Missile Defense Agency
Ballistic Missile Defense System (BMDS)

Programmatic Environmental Impact Statement

January 2007

VOLUME 1
FINAL BMDS PEIS

Department of Defense
Missile Defense Agency
7100 Defense Pentagon
Washington, DC 20301-7100

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE **JAN 2007**	2. REPORT TYPE	3. DATES COVERED **00-00-2007 to 00-00-2007**

4. TITLE AND SUBTITLE **Programmatic Environmental Impact Statement. Volume 1 Final BMDS PEIS**	5a. CONTRACT NUMBER 5b. GRANT NUMBER 5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER 5e. TASK NUMBER 5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Department of Defense,Missile Defense Agency,7100 Defense Pentagon,Washington,DC,20301-7100**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S) 11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**Same as Report (SAR)**	**400**	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18

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EXECUTIVE SUMMARY

Introduction

The National Environmental Policy Act (NEPA) of 1969, as amended; the Council on Environmental Quality (CEQ) regulations that implement NEPA (Code of Federal Regulations [CFR], Title 40, Parts 1500-1508); Department of Defense (DoD) Instruction 4715.9 *Environmental Planning and Analysis*; applicable service environmental regulations that implement these laws and regulations; and Executive Order (EO) 12114, Environmental Effects Abroad of Major Federal Actions (whose implementation is guided by NEPA and the CEQ implementing regulations) direct DoD lead agency officials to consider potential impacts to the environment when authorizing or approving Federal actions.

This Programmatic Environmental Impact Statement (PEIS) evaluates the potential environmental impacts of activities associated with the development, testing, deployment, and planning for decommissioning of the Ballistic Missile Defense System (BMDS). This PEIS considers the current technology components, assets, and programs that make up the proposed BMDS as well as the development and application of new technologies, and considers cumulative impacts of implementing the BMDS. A programmatic NEPA evaluation is the appropriate approach for projects that are large in scope, diverse geographically, and implemented in phases over many years. It provides the analytical framework that supports subsequent NEPA analysis of specific actions at specific locations within the overall system, i.e., tiering.

Purpose and Need for the Proposed Action

The purpose of the proposed action is for the Missile Defense Agency (MDA) to incrementally develop and field a BMDS that layers defenses to intercept ballistic missiles of all ranges in all phases of flight. The proposed action is needed to protect the United States (U.S.), its deployed forces, friends, and allies from ballistic missile threats. The BMDS is a key component of U.S. policy for addressing ballistic missile threats worldwide.

Proposed Action

The MDA is proposing to develop, test, deploy, and to plan for related decommissioning activities for an integrated BMDS using existing infrastructure and capabilities, when feasible, as well as emerging and new technologies, to meet current and evolving ballistic missile threats. The Secretary of Defense assigned this critical defense mission to the MDA.

Scope of the PEIS

This PEIS identifies, evaluates, and documents the potential environmental effects of developing, testing, deploying, and planning for the eventual decommissioning of a BMDS. Although extensive environmental analysis already exists for many of the existing and projected components of the proposed BMDS, this PEIS examines potential environmental impacts of MDA's concept for developing an integrated system, based on current Congressional and Presidential direction. The BMDS PEIS also assesses whether cumulative environmental effects would result from implementing the proposed action. Further, the BMDS PEIS provides the analytical framework for tiering subsequent specific NEPA analyses of activities including increasingly complex and robust System Integration Testing.

Consultation and Coordination

The MDA, as the lead agency responsible for preparing this PEIS, is required to coordinate with affected Federal, state, local, and tribal agencies, and other interested parties. The MDA identified several agencies that may be cooperating or consulting agencies within the requirements of NEPA for this PEIS. These agencies include National Oceanic and Atmospheric Administration National Marine Fisheries Service (NOAA Fisheries Service), U.S. Fish and Wildlife Service, the Advisory Council on Historic Preservation (ACHP), and the Federal Aviation Administration (FAA).

Consulting agencies may submit comments and provide data to support the environmental analysis, but they do not participate in the internal review of documents, issues, and analyses. A cooperating agency is any Federal agency, other than a lead agency, that has jurisdiction by law or special expertise with respect to any environmental impact involved in a proposal (or reasonable alternative) for legislation or other Federal action significantly affecting the quality of the human environment. (40 CFR 1508.5) MDA has held informal meetings with several agencies; however, MDA has not requested that any agencies participate as cooperating agencies for this PEIS.

Public Involvement

The MDA provided several opportunities and means for public involvement throughout the preparation of the BMDS PEIS. The CEQ implementing regulations for NEPA describe the public involvement requirements for agencies. (40 CFR 1506.6) Public participation in the NEPA process provides for and encourages open communication between the MDA and the public, thus promoting better decision-making.

Public involvement for the development of the BMDS PEIS began with the publication of the Notice of Intent (NOI) in the *Federal Register* (FR) (68 FR 17784) on April 11, 2003. The MDA invited the participation of Federal, state, and local agencies, Native

American Tribes, environmental groups, organizations, citizens, and other interested parties to assist in determining the scope and significant issues to be evaluated in the BMDS PEIS. MDA held public scoping meetings in accordance with CEQ regulations. (40 CFR 1501.7) Meetings took place in Arlington, Virginia on April 30, 2003; Sacramento, California on May 6, 2003; Anchorage, Alaska on May 8, 2003; and Honolulu, Hawaii on May 13, 2003. The purpose of the scoping meetings was to solicit input from the public on concerns regarding the proposed activities as well as to gather information and knowledge of issues relevant to analyzing the environmental impacts of the BMDS. The public scoping meetings also provided the public with an opportunity to learn more about the MDA's proposed action and alternatives. The MDA developed a publicly accessible web site, http://www.mda.mil/mdalink/html/mdalink.html, to provide information on the BMDS PEIS and request scoping comments. The MDA also established a toll-free phone and fax line, e-mail address, and U.S. postal service mailbox for submittal of public comments and questions.

During scoping, the MDA received 285 comments. Comments received pertaining to reasonable alternatives to the proposed action, resource areas, human health, and environmental impacts have been considered in this PEIS.

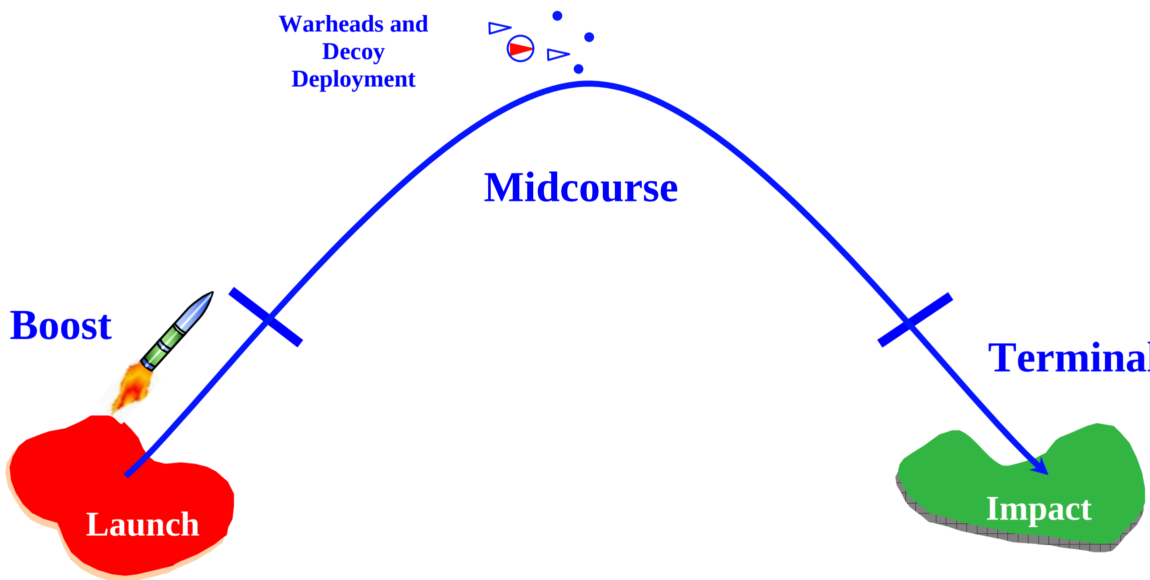
The public comment period began with the publication of the Notice of Availability (NOA) on September 17, 2004 in the FR by the Environmental Protection Agency (EPA). The NOA announced the availability of the Draft PEIS and requested comments on it. A downloadable version of the Draft PEIS was available on the BMDS PEIS web site and hardcopies of the document were placed in public libraries in the cities holding the public hearings. In October, 2004 MDA held public hearings in Arlington, Virginia; Sacramento, California; Anchorage, Alaska; and Honolulu, Hawaii. The MDA also placed legal notices in local and regional newspapers and notified state representatives of the public hearings. The purpose of these hearings was to solicit comments on the environmental areas analyzed and considered in the Draft PEIS. Appendix B contains a detailed description of the public comment period and a reproduction of the transcripts of the public hearings. The MDA's consideration of the approximately 8,500 comments received on the Draft PEIS and responses to in-scope comments can be found in Appendix K of this PEIS. Additional areas of analysis—orbital debris, perchlorate, and radar impacts to wildlife—are addressed in more technical detail in Appendices L, M, and N. The Final BMDS PEIS will be available for download at the site address listed above.

The Proposed BMDS

Conceptually, the BMDS would be a layered system of defensive weapons (i.e., lasers and interceptors); sensors (i.e., radars, infrared, optical, and lasers); Command and Control, Battle Management, and Communications (C2BMC); and support assets (i.e., auxiliary equipment, infrastructure and test assets); each with specific functional

capabilities, working together to defend against all classes and ranges of threat ballistic missiles in the three flight phases. A flight phase is a portion of the path taken by a threat missile moving through the atmosphere or space. The three flight phases of a ballistic missile are boost, midcourse, and terminal. Exhibit ES-1 describes these three phases. Multiple defensive weapons would be used to create a layered defense comprised of multiple intercept opportunities.

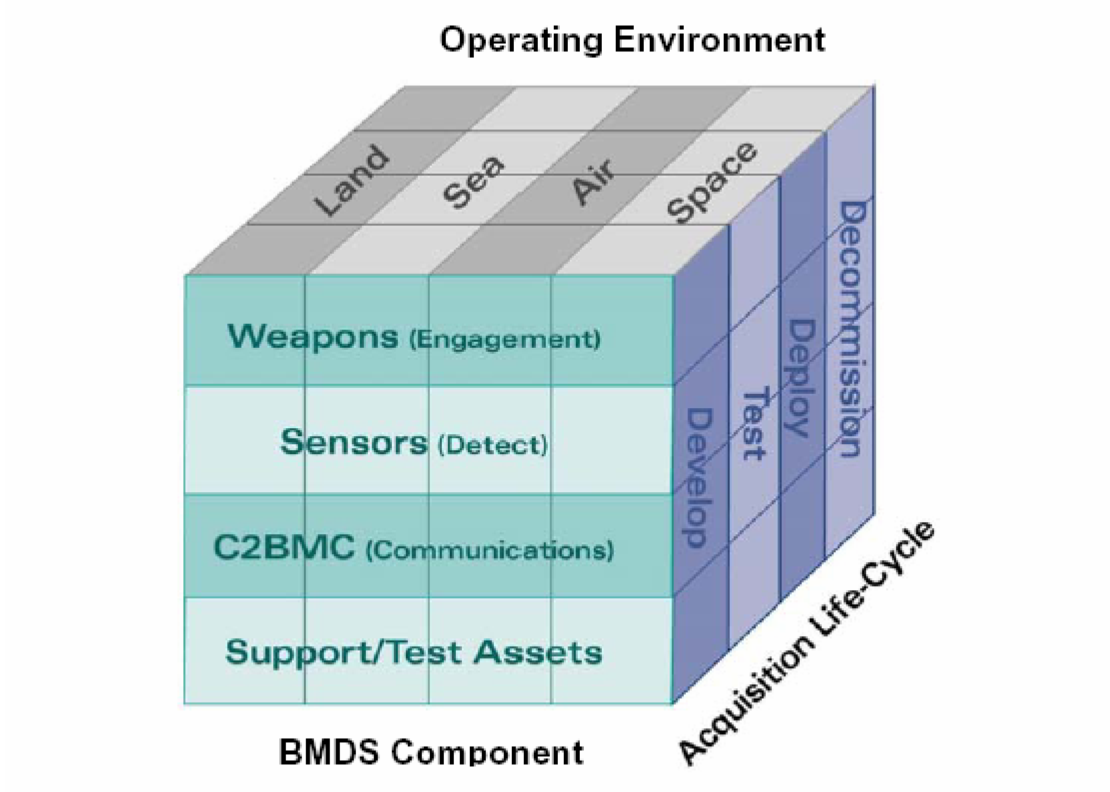
Exhibit ES-1. Ballistic Missile Flight Phases



Flight Phase	Description
Boost	First phase - rocket engine is ignited, missile lifts off and sets out on a specific path.
Midcourse	Second phase - begins when the rocket engine cuts off and the missile continues on a ballistic trajectory. Warheads and decoys may be deployed in this phase.
Terminal	Third phase - final portion of a ballistic trajectory between the midcourse phase and trajectory termination.

To determine environmental impacts, this PEIS analyzes the proposed BMDS in terms of its components, i.e., weapons, sensors, C2BMC, and support assets. These components become part of the BMDS through the acquisition life cycle phases – develop, test, deploy, and decommission. The components and activities could occur in various land, sea, air, and space operating environments. Exhibit ES-2 depicts the multi-dimensional complexities involved in considering the impacts of implementing an integrated BMDS.

Exhibit ES-2. Complexities of an Integrated BMDS



Components of the BMDS

The proposed BMDS would be comprised of components, i.e., weapons, sensors, C2BMC, and support assets. These are the systems and subsystems of logically grouped hardware and software that perform interacting tasks to provide BMDS functional capabilities. Historically, MDA primarily focused on developing stand-alone elements with specific defensive capabilities. The proposed approach maximizes flexibility to develop and test an integrated system while allowing initial capabilities to be fielded.

- **Weapons**. Weapons consisting of interceptors and high energy lasers (HELs) would be used to negate threat missiles. Interceptors would use either direct impact or directed fragmentation technology. BMDS weapons are designed to intercept threat ballistic missiles in one or more phases of flight and could be activated from land, sea-, air-, or space-based platforms.

- **Sensors**. BMDS sensors provide the relevant incoming data for threat ballistic missiles. They acquire, record, and process data on threat missiles and interceptor missiles; detect and track threat missiles; direct interceptor missiles or other defenses (e.g., lasers); and assess whether a threat missile has been destroyed. These sensors include signal-processing subcomponents, which receive raw data and use hardware and software to process these data to determine the threat missile's location, direction,

velocity, and altitude. The data from these sensors would travel through the communication systems of the proposed BMDS to Command and Control (C2) where a decision would be made to employ a defensive weapon such as launching an interceptor. The technologies used by existing and proposed BMDS sensors are based on the frequency or electromagnetic (EM) energy spectrum used by the sensor and include radar, infrared, optical, and laser systems.

- **C2BMC**. C2BMC would effectively integrate all components of the BMDS and would consist of electronic equipment and software that enable military commanders to receive and process information, make decisions, and communicate those decisions regarding the engagement of threat missiles. Specifically, C2BMC would receive, fuse, and display tracking and status data from multiple components so that commanders at various locations would have the same integrated operating picture and could make coordinated decisions about deploying weapons. The BMDS C2BMC includes three primary parts, C2, Battle Management (BM), and Communications. C2 would provide an integrated architecture to plan, direct, control, and monitor BMDS activities. BM would control the launching or firing of missiles and integrate the surveillance, detect/track/classify, engage, and assess across the layered defenses. Communications would allow all BMDS components to exchange data and network with BMDS assets.

- **Support Assets**. Support assets would be used to facilitate BMDS development, testing, and deployment. Support assets include support equipment, infrastructure, and test assets. Support equipment includes general transportation and portable equipment (e.g., automotive, ships, aircraft, rail, generators); BMDS Test Bed equipment (e.g., aircraft, vehicles, ships, mobile launch platforms, operator control units, sensor operations equipment [antennas, electronic equipment, cooling units, prime power units]); and weapons basing platforms (e.g., Aegis Cruiser and Airborne Laser [ABL] aircraft). Infrastructure includes docks, shipyards, launch facilities, and airports/air stations. Test assets include test range facilities, targets (missiles and drones), countermeasure devices, simulants, test sensors, optical and infrared cameras, computers, and observation vehicles. These test assets would simulate a threat missile in a realistic environment and assess and provide data used to enhance the performance of BMDS components in negating those threats. Some of the equipment (i.e., radar and tracking stations) and infrastructure (e.g., launch facilities) and all of the test assets comprise the BMDS Test Bed.

Acquisition Life Cycle Phases

The MDA, as the acquisition agency for the BMDS, has implemented a new, more flexible approach to its development. This approach is capability driven and component-based. Capability-based planning allows MDA to develop capabilities and system performance objectives based on technology feasibility, engineering analyses, and the

potential capability of the threat. Spiral development is an iterative process for developing the BMDS by refining program objectives as technology becomes available through research and testing with continuous feedback among MDA, the test community, and the military operators. Thus, MDA can consider deployment of a missile defense system that has no specified final architecture and no set of operational requirements but which will be improved incrementally over time. Development, testing, and deployment of an integrated BMDS would occur over several years using this evolutionary, spiral development process. Each new technology would go through development; promising technologies would go through testing and demonstration; and proven technologies would be incorporated into the BMDS.

- **Development**. Development includes the various activities that would support research and development of the BMDS components and overall systems. This would include planning, budgeting, research and development, systems engineering, site preparation and construction, repair, maintenance and sustainment, manufacture of test articles and initial testing, including modeling, simulation, and tabletop exercises.

- **Testing**. Testing of the BMDS involves demonstration of BMDS elements and components through test and evaluation. The successful demonstration of the BMDS would rely on a robust testing program aimed at producing credible system characterization, verification, and assessment data. To confirm these capabilities, MDA would continue to develop Test Beds using existing and new land-, sea-, air-, and space-based assets. Some construction at various geographic locations would be required to support infrastructure and assets where BMDS components and the overall system would be tested. Testing of the BMDS includes ongoing and planned tests (e.g., ground tests [GTs], flight tests) of components that might be incorporated into the BMDS, as well as tests of the layered, integrated BMDS through increasingly realistic System Integration Tests through 2010 and beyond.

- **Deployment**. Deployment of the BMDS refers to the fielding (including the manufacture, site preparation, construction and transport of systems) and sustainment (including operations and maintenance, training, upgrades, and service life extension) of BMDS architecture. The evolving BMDS is intended to have the capability over time to deploy different combinations of interoperable components. Deployment also would involve the transfer of facilities, elements and programs to the military services. On December 17, 2002, President Bush directed the fielding of initial defensive operation (IDO) capabilities by 2004, which would provide limited protection to defend the U.S. against ballistic missile attack. In October 2004, MDA achieved a limited missile defense capability (LDC) when certain BMDS components could also be placed on alert and used in defensive operations.

- **Decommissioning**. Decommissioning would involve the demilitarization and final removal and disposal of the BMDS components and assets. Plans would be made for

decommissioning BMDS components by either demolition or transfer to other uses or owners.

Alternatives

In this PEIS, MDA considers two alternatives to implementing an integrated BMDS that address the use of weapons components from land-, sea-, air-, and space-based platforms in addition to the No Action alternative as required by NEPA.

- **Alternative 1**. Under Alternative 1, the MDA would develop, test, deploy, and plan to decommission land-, sea-, and air-based platforms for BMDS weapons components and related architecture and assets. Alternative 1 would include space-based sensors, but would not include space-based defensive weapons.

- **Alternative 2.** Under Alternative 2, the MDA would develop, test, deploy, and plan to decommission land-, sea-, air-, and space-based platforms for BMDS weapons components and related architecture and assets. Alternative 2 would be identical to Alternative 1, with the addition of space-based defensive weapons.

- **No Action Alternative**. Under No Action the MDA would not develop, test, deploy, or plan for decommissioning activities for an integrated BMDS. Instead, the MDA would continue existing development and testing of discrete systems as stand-alone missile defense capabilities. Individual systems would continue to be tested but would not be subjected to System Integration Tests.

Affected Environment

To assess the impacts of implementing the proposed BMDS, it is necessary to characterize the existing condition of the affected environment in the locations where various BMDS implementation activities are proposed to occur. The affected environment includes all land, air, water, and space environments where proposed activities are reasonably foreseeable. For this PEIS, the affected environment includes all existing locations for ranges, installations, and facilities that the MDA has used, uses, or proposes to use for the BMDS both in the U.S. and outside the continental U.S. MDA determined that activities associated with the proposed BMDS might occur in locations around the world. Therefore, the affected environment has been considered in terms of global biomes, broad ocean areas, and the atmosphere.

Each biome covers a broad region, both geographically and ecologically for both domestic and international locations where components of the proposed BMDS may be located or operated. Climate, geography, geology, and distribution of vegetation and wildlife determine the distribution of the biomes. Using biomes as affected environment designations enables future site-specific environmental documentation to tier from this

PEIS. Note that there are no reasonably foreseeable BMDS activities that would occur in Antarctica; therefore, it is not included among the terrestrial biomes.

The affected environment has been divided into nine terrestrial biomes, the Broad Ocean Area (BOA), and the Atmosphere. Exhibit ES-3 describes the affected environment, and Exhibit ES-4 illustrates the global distribution of the biomes.

Exhibit ES-3. Affected Environment Descriptions[1]

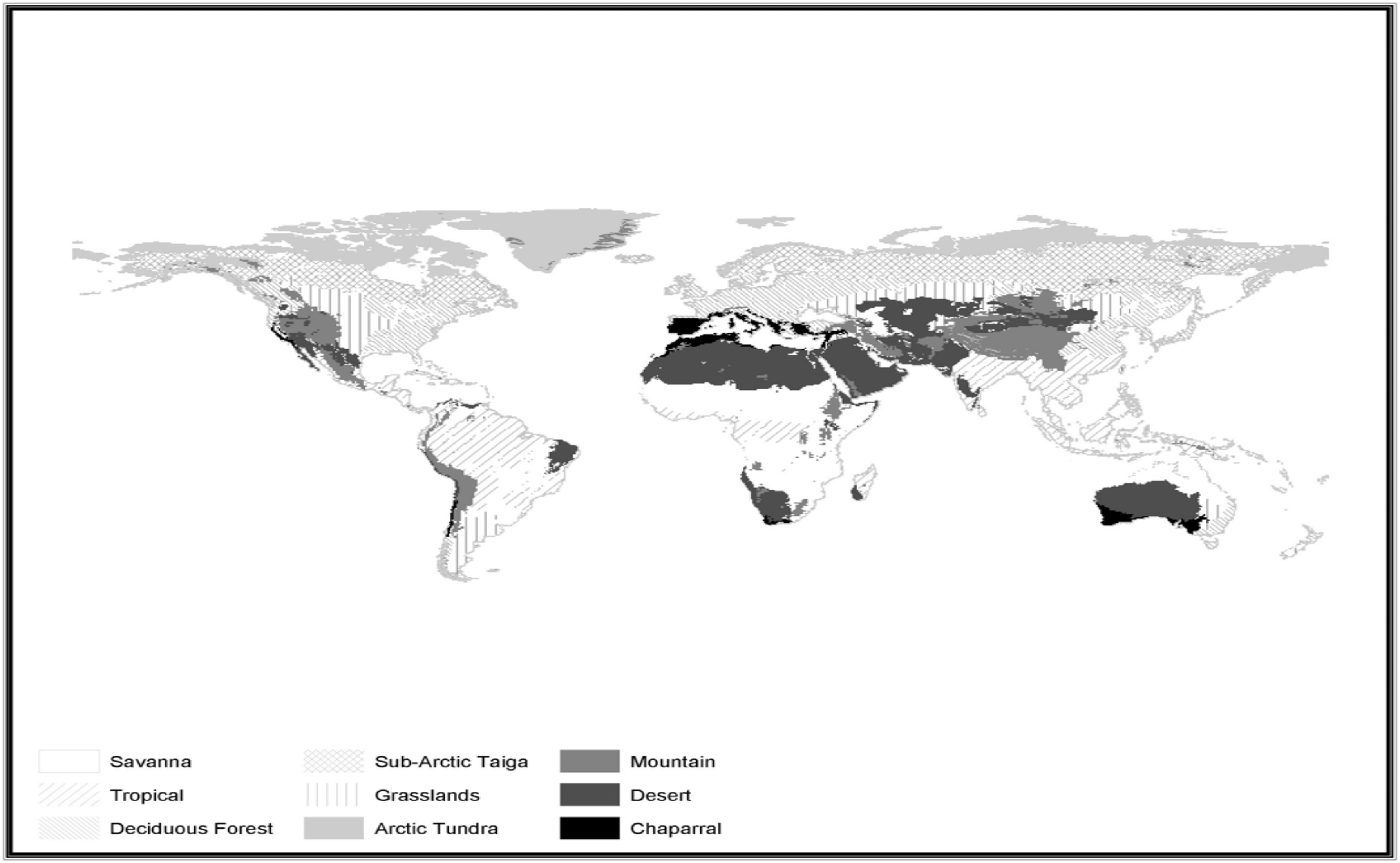
Description	Latitudinal Location	Areas of Interest for the BMDS
Arctic Tundra Biome	Areas above 60° North	Arctic regions of North America and the arctic coastal regions that border the North Atlantic Ocean, North Pacific Ocean, and Arctic Ocean, including parts of Alaska, Canada, and Greenland
Sub-Arctic Taiga Biome	Between 50° and 60° North	Sub-arctic regions of North America and sub-arctic coastal regions that border the North Pacific Ocean, including portions of Alaska
Deciduous Forest Biome	Mid-latitudes, between the polar regions and tropical regions	Eastern and northwestern U.S. and portions of Europe
Chaparral Biome	Western coastal regions of continents between 30° and 40° both North and South of the equator	Portion of the California coast and coastal region of the Mediterranean from the Alps to the Sahara Desert and from the Atlantic Ocean to the Caspian Sea
Grasslands Biome	No particular latitudinal range; occurs in the interior of all continents, except Antarctica	Prairie regions of Midwestern U.S.
Desert Biome	Between 15° and 35° both North and South of the equator	Arid environment of southwestern U.S.

[1] The latitudinal designations identify the general location for each biome; however, the biomes do not have rigid edges that begin and end at these latitudes. Therefore, there may be some overlap of biomes at or near these latitudinal designations.

Exhibit ES-3. Affected Environment Descriptions[1]

Description	Latitudinal Location	Areas of Interest for the BMDS
Mountain Biome	No particular latitudinal range; applies to areas with high elevations just below and above the snow line of a mountain	Rocky Mountains in the western U.S. and Alps in Central Europe
Tropical Biome	Between 23.5° North (Tropic of Cancer) and 23.5° South (Tropic of Capricorn)	Pacific Equatorial Islands
Savanna Biome	Between 5° and 20° both North and South of the equator	Northern Australia
BOA	No particular latitudinal range	Pacific, Atlantic and Indian Oceans
Atmosphere	No particular latitudinal range; refers to the atmosphere that envelops the entire Earth	Four principal atmospheric layers: troposphere, stratosphere, mesosphere, and ionosphere (or thermosphere)

Exhibit ES-4. Map of Global Biomes



Source: Modified From National Geographic, 2003b

The characteristics (e.g., climate, soil types, flora and fauna) that define global biomes are the same regardless of whether the biome area of concern is coastal or inland. However, unique features (e.g., wetlands, estuaries, wind currents, hurricanes) of coastal biome areas may affect the environmental impacts. Therefore, the Affected Environment discusses these unique features within the biome descriptions. Describing coastal areas as part of the larger inland biomes minimizes repetition among the descriptions yet captures the important aspects of the coastal areas in a way suitable for impacts analysis. For this PEIS, the existing environmental conditions within each biome, as well as the BOA and the Atmosphere, were assessed based on several resource areas, as appropriate.

Resource Areas

The resource areas considered in this analysis are those resources that can potentially be affected by implementing the proposed BMDS. Some resource areas are site-specific or local in nature and therefore cannot be effectively analyzed in this type of programmatic document. The potential impacts on these resource areas are more appropriately discussed in subsequent site-specific documentation, tiered from this PEIS. The resource areas analyzed in this PEIS include: air quality, airspace, biological resources, geology and soils, hazardous materials and hazardous waste, health and safety, noise, transportation, and water resources. The MDA has included orbital debris as a resource consideration because of the likelihood of orbital debris occurring from various launch and test activities and its potential for impact to health and safety and the environment.

Other resource areas including cultural resources, environmental justice, land use, socioeconomics, utilities, and visual resources depend upon site-specific or local factors. Each of these was discussed regarding methodology and thresholds for significance to provide the reader with a “roadmap” for performing future site-specific analyses tiering from this PEIS. These discussions outline the types of information that would be needed to conduct site-specific analyses and identify the steps necessary to ensure that potential impacts are thoroughly and appropriately considered.

Environmental Consequences

To determine environmental consequences or impacts of implementing the proposed BMDS, its components (i.e., weapons, sensors, C2BMC, and support assets) were considered as they are developed, tested, deployed and decommissioned during these acquisition life cycle phases. Not all of the activities associated with the proposed BMDS are expected to produce environmental impacts. Only those activities with expected impacts for each life cycle phase are identified. Further, only those activities that are considered reasonably foreseeable are analyzed in this PEIS. BMDS programs that are largely conceptual are not analyzed in this document.

Because of the extensive nature of this project, this PEIS analyzes the BMDS as described in the following four steps.

Step 1 – Identify and Characterize Activities

The BMDS is organized by component (i.e., weapons; sensors; C2BMC; and support assets). Each component has life cycle phase activities associated with developing, testing, deploying, and decommissioning those components within the BMDS. These activities produce environmental impacts, which are examined in this PEIS. To consider impacts of the BMDS, the emissions/stressors from the component life cycle phases were identified and characterized.

Step 2 – Identify Activities with No Potential for Impact

Once the activities were identified, analysis revealed that some of those activities had no potential for (significant) impact. This conclusion was reached because either previous NEPA analysis revealed insignificant impacts, or because the activity was typically categorically excluded. These activities are not further analyzed in this PEIS.

Step 3 – Identify Similar Activities across Life Cycle Phases

The remaining activities with the potential for environmental impacts were then examined to determine which had similar environmental impacts. For example, impacts associated with site preparation and construction in the development phase would be the same as impacts from site preparation and construction activities in the testing and deployment phases of the life cycle. Accordingly many activities were addressed together to eliminate redundancy.

Step 4 – Conduct Environmental Analyses

The final step in the BMDS analysis is to determine the respective impact resulting from the proposed activities. The significance of an impact that an activity has on the environment is a function of the nature of the receiving environment. For example, a booster launch has different emissions than those resulting from activating a chemical laser. Whether those emissions create impacts and the degree of significance of these impacts depends, among other things, upon the environment in which they are released.

In this analysis, the PEIS considers the emissions/stressors from each component's activity in the context of each resource area (e.g., air quality, biological resources, water resources, etc.). Impacts were distinguished based on the different operating environments (land, sea, and air for Alternative 1 and land, sea, air, and space for Alternative 2) in which the activity would occur. These impacts were further distinguished based on the worldwide biomes in which the activity would occur.

As a result, the PEIS is organized by BMDS component, examining each resource area, and distinguishing between operating environments in the context of a particular biome. The analysis describes where the impacts differ based on the operating environment or biome.

Life Cycle Phase Activities

Development phase activities with the potential to produce environmental impacts include site preparation and construction and testing. Both of these activities occur in other life cycle phases for the proposed BMDS, and so the analysis has been combined where appropriate. For example, testing of component prototypes (development phase) has been assumed to cause the same or similar impacts as testing of component test articles (test phase), and so these activities were analyzed as one activity.

Test phase activities were considered in two distinct analyses: one focused on the components and their individual test activities, and the other focused on System Integration Testing which could include multiple components with one or more attempted intercepts to test system capability and effectiveness in increasingly robust and realistic test scenarios.

Component test activities assumed to have potential impacts on the environment were considered for each component as shown in Exhibit ES-5.

Exhibit ES-5. Component Test Activities with Potential Impacts

Component	Activity	Source of Impact	Impacts Analysis
Weapons-Laser	Manufacturing of Test Articles	Manufacturing/assembly of laser components and chemicals	Activity categorically excluded or previously analyzed and found to have no significant impact. Rationale presented in Section 4.1.1.10 Support Assets - Test Assets
	Site Preparation and Construction	Construction or modifications necessary to support laser use/firing	Section 4.1.1.9 Support Assets - Infrastructure

Exhibit ES-5. Component Test Activities with Potential Impacts

Component	Activity	Source of Impact	Impacts Analysis
	Transportation	Transport of the laser and chemicals to appropriate location	Activity categorically excluded or previously analyzed and found to have no significant impact. Rationale presented in Section 4.1.1.8 Support Assets - Support Equipment
	Activation	Firing the laser	Section 4.1.1.1 Weapons - Lasers
Weapons-Interceptor	Manufacturing of Test Articles	Manufacturing interceptor components and propellants	Activity categorically excluded or previously analyzed and found to have no significant impact. Rationale presented in Section 4.1.1.10 Support Assets - Test Assets
	Site Preparation and Construction	Construction or modifications necessary to support launch	Section 4.1.1.9 Support Assets - Infrastructure
	Transportation	Transport of the booster, kill vehicle, and propellants to the launch location	Activity categorically excluded or previously analyzed and found to have no significant impact. Rationale presented in Section 4.1.1.8 Support Assets - Equipment
	Prelaunch	Assembly and fueling of the booster or kill vehicle, as appropriate	Section 4.1.1.2 Weapons - Interceptors

Exhibit ES-5. Component Test Activities with Potential Impacts

Component	Activity	Source of Impact	Impacts Analysis
	Launch/Flight	Ignition of rocket motors and flight of boosters or separation of kill vehicle and subsequent flight along its trajectory	Section 4.1.1.2 Weapons - Interceptors
	Postlaunch	Clean up or debris recovery, if required	Section 4.1.1.2 Weapons - Interceptors
Sensors	Manufacturing	Manufacturing/assembly of the sensor hardware and software	Activity categorically excluded or previously analyzed and found to have no significant impact. Rationale presented in Section 4.1.1.10 Support Assets - Test Assets
	Site Preparation and Construction	Construction or modifications necessary to support sensor use	Section 4.1.1.9 Support Assets - Infrastructure
	Transportation	Transport of the sensor to appropriate location	Activity categorically excluded or previously analyzed and found to have no significant impact. Rationale presented in Section 4.1.1.8 Support Assets - Equipment
	Activation	Use of the sensor	Sections 4.1.1.3 Sensors - Radar, 4.1.1.4 Sensors - Infrared and Optical, and 4.1.1.5 Sensors - Laser

Exhibit ES-5. Component Test Activities with Potential Impacts

Component	Activity	Source of Impact	Impacts Analysis
C2BMC	Manufacturing	Assembly of associated hardware and software	Activity categorically excluded or previously analyzed and found to have no significant impact. Rationale presented in Section 4.1.1.10 Support Assets - Test Assets
	Site Preparation and Construction	Construction or modification for computer terminals, antennas, and underground cable trenching	Section 4.1.1.9 Support Assets - Infrastructure
	Transportation	Transport of C2BMC to appropriate location	Activity categorically excluded or previously analyzed and found to have no significant impact. Rationale presented in Section 4.1.1.8 Support Assets - Equipment
	Activation	Use of computer terminals, antennas, and underground cable	Sections 4.1.1.6 C2BMC - Computer Terminal and Antennas, 4.1.1.7 C2BMC - Underground Cable
Support Assets-Support Equipment	Manufacturing	New or major modification of existing support equipment	Activity categorically excluded or previously analyzed and found to have no significant impact. Rationale presented in Section 4.1.1.10 Support Assets - Test Assets

Exhibit ES-5. Component Test Activities with Potential Impacts

Component	Activity	Source of Impact	Impacts Analysis
	Operational Changes	Implementation of new operating parameters of existing support equipment	Section 4.1.1.8 Support Assets - Equipment
	Site Preparation and Construction	New construction or major modification of existing infrastructure	Section 4.1.1.9 Support Assets - Infrastructure
	Transportation	Transport of support equipment	Activity categorically excluded or previously analyzed and found to have no significant impact. Rationale presented in Section 4.1.1.8 Support Assets - Equipment
Support Assets-Infrastructure	Site Preparation and Construction	Construction or modification of infrastructure	Section 4.1.1.9 Support Assets - Infrastructure
Support Assets-Test Assets	Manufacturing	Assembly of hardware/software associated with the test sensor	Activity categorically excluded or previously analyzed and found to have no significant impact. Rationale presented in Section 4.1.1.10 Support Assets - Test Assets
	Site Preparation and Construction	Construction or modifications necessary to support the test sensor or launch	Section 4.1.1.9 Support Assets - Infrastructure

Exhibit ES-5. Component Test Activities with Potential Impacts

Component	Activity	Source of Impact	Impacts Analysis
	Transportation	Transport of the sensor, booster and propellants to the test location	Activity categorically excluded or previously analyzed and found to have no significant impact. Rationale presented in Section 4.1.1.8 Support Assets - Equipment
	Activation	Use of the test sensor in a test event	Section 4.1.1.3 Sensors - Radar, 4.1.1.4 Sensors - Infrared and Optical, and 4.1.1.5 Sensors - Laser
	Prelaunch	Assembly and fueling of the booster as appropriate	Section 4.1.1.2 Weapons - Interceptors
	Launch/Flight	Ignition of rocket motors, separation from launch platform, and flight of the boosters or separation of the target object and subsequent flight along its trajectory	Section 4.1.1.2 Weapons - Interceptors
	Use of Countermeasures, Simulants or Drones	Use and deployment of various countermeasures, simulants a or drones to support testing	Section 4.1.1.10 Support Assets - Test Assets
	Postlaunch	Clean up or debris recovery to include launch platform, countermeasures, and simulants, if required	Section 4.1.1.2 Weapons - Interceptors

System Integration Testing of the BMDS would occur at the system level. System Integration Tests evaluate the ability of various component configurations to work together. System Integration Testing would be used to assess the ability of BMDS

components to work interoperably to meet the required functional capabilities of the BMDS as a system and to demonstrate performance. System Integration Tests would integrate existing and planned components such as sensors, weapons, and C2BMC. This PEIS assesses the potential for environmental impacts of integrated BMDS testing under Alternatives 1 and 2. Test integration activities would involve land-, sea-, and air-based operating environments for weapons; and land-, sea-, air- and space-based operating environments for sensors, C2BMC, and support assets for Alternative 1. Assessment of Alternative 2 considers only the additional impacts of the proposed space-based operating environment for interceptors. System Integration Tests with the potential for environmental impacts are shown in Exhibit ES-6.

Exhibit ES-6. Description of System Integration Tests

Test	Activities
Integrated Ground Tests (GTs)	GTs are tests used to collect data for BMDS components characterization and assessment and do not include booster function flight tests. GTs aim to reproduce the existing state of BMDS architecture, typically components scheduled for upcoming flight tests, to prepare for those flight tests and to assess component performance. For the purposes of this PEIS GTs do not include activities associated with components but rather have been focused on System Integration Testing.
System Integration Flight Tests (SIFTs)	SIFTs are conducted to verify the integration of select BMDS components. These tests generally include a target launch, sensors tracking the target, laser activation or an interceptor launch, and sensors to determine whether the target was destroyed. The number of sensors, weapons, and targets used in a SIFT can be adjusted to create the desired test scenario.

The analysis of intercept impacts includes a discussion of the impact of debris from an intercept. Depending on the location used for testing or deployment of weapons, debris may impact either inland or in marine environments. Therefore, impacts from postlaunch activities involving intercepts are subcategorized based on where intercept debris would be likely to impact. For any single intercept, it was assumed that the debris impacts would occur within a single receiving environment, either on land or in water.

Not all test activities would have environmental impacts and MDA has determined that modeling, simulation and analysis; modeling defense integration exercises; and integrated missile defense wargames would not result in significant impacts. These are virtual tests (modeling and computational analysis) or software compatibility and communication tests that would be conducted within existing laboratory or test facilities.

Deployment activities with potential impacts on the environment would include production of the components, site preparation and construction, use of human services, transport of components to the deployment site, testing (prelaunch, launch/flight, activation, postlaunch) and maintenance or sustainment of the components. For purposes of this analysis, the environmental impacts associated with transportation are assumed to be the same as the impacts associated with transporting the components to a test location and the impacts associated with maintenance are assumed to be the same as or similar to the impacts associated with manufacturing activities.

Decommissioning activities would include demilitarization and disposal or replacement of the component, recycling and disposal of hazardous materials. The environmental impacts associated with decommissioning of specific components would be more appropriately addressed in subsequent tiered environmental analyses; however, this PEIS provides a roadmap for considering impacts of decommissioning for each component.

Impacts from accidents and spills are considered where appropriate in this analysis. Specifically, the impacts from booster failures and from spills or releases of laser chemicals, booster propellants, and fuels used to power support assets have been considered. Boosters can fail on or directly above the launch pad or at some point during flight. If a booster fails on or above the pad, there is a potential for damage to infrastructure at and around the launch area. The impact of this type of booster failure is most appropriately addressed in site-specific analysis. If a booster fails during flight, it may be possible to use a Flight Termination System (FTS), if there is one on the vehicle, to destroy the booster. In this instance, the resulting debris would be similar to that produced during an intercept. If an FTS is not used, the booster would fall substantially intact to the surface. The resulting impact from both in-flight failures would depend on the specific location and when in the flight the failure occurred. The quantity of residual propellant released may be greater under a booster failure then during a successful booster flight or intercept. Spills or releases of propellants and fuels would be handled in accordance with standard operating procedures at each facility, range or installation, and therefore, would not be expected to pose significant impacts to the environment.

Cumulative impacts of Alternative 1 and Alternative 2 have been considered in this PEIS. The CEQ NEPA regulations define cumulative impacts as those impacts on the environment that result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. (40 CFR 1508.7)

Summary of Environmental Impacts – Alternative

This alternative considers the use of land-, sea-, and air-based platforms for BMDS weapons components. Alternative 1 would include space-based sensors, but would not include space-based defensive weapons. A summary of potential environmental effects

from Alternative 1 is provided by subcomponent in Exhibits ES-7 through ES-10. The summary tables are organized by component and subcomponent. The analyses are specific to each resource area based on the impacts from the activities associated with the subcomponent. The impacts associated with the manufacturing, site preparation and construction, and transportation activities of components are discussed under Support Assets.

Exhibit ES-7. Summary of Environmental Impacts of Alternative 1 - Weapons

Resource Area	Lasers	Interceptors
Air Quality	Emissions from laser operation (less than 30 seconds) would be minimal and would be dispersed by wind and would not significantly affect local or regional air quality.	Negligible amounts of fuel and oxidizer vapors might be released during propellant transfers. Most launch emissions would be dispersed by wind and would not significantly affect local or regional air quality or ozone depletion.
Airspace	Following required scheduling and coordination procedures would minimize the potential for adverse impacts to airspace.	Following required scheduling and coordination procedures would minimize potential for adverse impacts to airspace.
Biological Resources	Emissions, noise, and the laser beam from laser activation could negatively impact biological resources. Emitted chlorine might damage vegetation; hydrogen chloride (HCl) might irritate birds flying through the exhaust cloud or reach and disrupt aquatic ecosystems. Wildlife could be startled by noise from laser support equipment. The laser beam could pose fire hazards to vegetation and eye and skin hazards to wildlife. However, impacts to these resources would be minimal if the beam is contained or directed upward.	The presence of launch-related personnel prior to launch, launch noise, and launch emissions could impact biological resources during launch; however, launches are relatively infrequent and would not be expected to significantly impact wildlife. Debris impacting water has the potential to cause non-acoustic effects to biological resources from physical impact from falling debris, entanglement in debris, and contact with or ingestion of debris or propellants. However, these effects would not significantly impact biological resources.
Geology and Soils	Soil acidity might be affected as a result of chlorine emissions from laser activation. Magnitude of impact would be related to the amount of limestone in the soils. However, chlorine emissions are small and laser activation relatively infrequent and the impacts to geology and soils would not be significant.	Potential impacts would not be significant. Launch emissions that occur above the mixing height or above the troposphere would not cause impacts. Soil acidity might be affected as a result of HCl emissions from some launch activities. Magnitude of impact would be related to the amount of limestone in the soils. Debris from boosters and kill vehicles could hit and affect the surface and soils where they impact, but there would be no significant impact on geology.
Hazardous Materials and Hazardous Waste	Spent laser chemicals and wastewater would be treated and disposed in accordance with applicable transport and management regulations to prevent impacts. Therefore, no significant impacts from hazardous materials or hazardous waste would be expected.	Applicable regulations and operating procedures would be followed and would prevent impacts from improper transport, management, or disposal of hazardous materials or hazardous waste.
Health and Safety	Following spill prevention and control procedures would reduce potential health and safety impacts from accidental releases of laser chemicals. Hazard distances would be established to protect against skin or eye hazards from the laser beam and inhalation hazards from air emissions; therefore, no significant health and safety impacts would be expected.	Potential health and safety impacts include exposure to explosives, contact with launch debris, and exposure to launch noise. Launches would take place on facilities with restricted access, preventing exposure of the public to these hazards. Following appropriate procedures during fueling and prelaunch operations would reduce potential impacts. On-site personnel would be protected from launch event hazards; therefore, no significant health and safety impacts would be expected.

Exhibit ES-7. Summary of Environmental Impacts of Alternative 1 - Weapons

Resource Area	Lasers	Interceptors
Noise	The public would be excluded from areas where noise from operational equipment would be detrimental and workers would use recommended hearing protection. Therefore, no significant noise impacts would be expected.	The launch and flight of boosters would produce launch noise and sonic booms. The public would not be in proximity to launch sites and therefore would not be exposed to significant noise levels. Launch personnel would either leave the area or wear recommended hearing protection. Therefore, no significant noise impacts would be expected.
Transportation	Air traffic might be impacted by laser activation. Following required scheduling and coordination procedures would minimize the potential for adverse impacts. No significant impacts would be expected to other transportation modes.	Impacts on traffic due to temporary road closures are not expected to be significant. Notices to Airmen (NOTAMs) and Notices to Mariner (NOTMARs) would provide sufficient warning to prevent significant impacts to air and marine transportation.
Water Resources	Some emissions from laser activation have the potential to temporarily and locally increase the acidity of surface waters. However, these emissions would be diluted and dispersed by receiving waters. Therefore, no significant water resource impacts would be expected.	Following appropriate procedures during fueling operations would reduce the potential for propellants to impact water resources. Some emissions from launches could temporarily and locally increase acidity of surface waters. However, these emissions would be diluted and dispersed by receiving waters and would not be expected to pose significant impacts to water resources.
Orbital Debris	N/A	Debris created from a booster failure while operating in the exoatmosphere would reenter Earth's atmosphere within a few months. Because the debris would be on orbit for a relatively short time it would not have a significant impact on orbiting structures. In addition, only a small amount of debris would survive reentry and therefore no significant impacts are expected.

Exhibit ES-8. Summary of Environmental Impacts of Alternative 1 - Sensors

Resource Area	Radars	Infrared and Optical Sensors	Laser Sensors
Air Quality	Emissions from radars would be limited to generator exhaust, which are considered in Support Assets.	Emissions from infrared and optical sensors would be limited to generator exhaust, which are considered in Support Assets.	Gas laser sensors would use inert gases, e.g., helium, nitrogen (N_2), and carbon dioxide (CO_2), which can be asphyxiants. Leaks of these gases would be insignificant relative to ambient oxygen levels; therefore no significant air quality impacts would be expected.
Airspace	NOTAMs would be issued and pilots would be restricted from electromagnetic radiation (EMR) hazard areas during radar activation. Restrictions would be short term and would not significantly impact airspace.	Activation of infrared and optical sensors would not interfere with airspace; therefore, no impacts to airspace would be expected.	Ground testing of laser sensors would be conducted in an established controlled firing area. Activation of laser sensors from air platforms would occur at an upward angle above commercial aircraft traffic. Therefore, no significant airspace impacts would be expected.
Biological Resources	There may be some risk of thermal heating to birds from the COBRA DANE radar as discussed in Appendix N, Impacts of Radar on Wildlife. However, MDA has proposed mitigation measures such as limiting the use of the radar during migratory seasons and when flocks may be in the vicinity. Therefore, no significant biological resource impacts would be expected.	Activation of infrared and optical sensors would not interfere with biological resources; therefore, no significant biological resource impacts would be expected.	Birds and mammals in the laser beam path could suffer eye damage. The short duration of laser activation and small range area would minimize impacts. Direction of laser sensor beams from space platforms towards the Earth's surface, would suffer distortion from atmospheric conditions reducing the radiance level of the lasers. Therefore, no significant impacts to biological resources would be expected.
Geology and Soils	Impacts would be limited to accidental spills of diesel fuel or coolants from support generators, which are considered in Support Assets.	Impacts would be limited to accidental spills of diesel fuel or coolants from support generators, which are considered in Support Assets.	Activation of laser sensors would not impact geology and soils.
Hazardous Materials and Hazardous Waste	Applicable regulations and procedures would be followed and would minimize impacts from management of hazardous materials or waste.	Applicable regulations and procedures would be followed and would minimize impacts from management of hazardous materials or waste.	Refrigerant 404, an ozone-depleting substance, may be used to cool some laser sensors. These would be closed loop systems, with replacement of refrigerant only during routine maintenance performed according to applicable regulations, therefore, no significant impacts from hazardous materials or waste management would be expected.

Exhibit ES-8. Summary of Environmental Impacts of Alternative 1 - Sensors

Resource Area	Radars	Infrared and Optical Sensors	Laser Sensors
Health and Safety	Prior to activation of radars, an EMR survey would be conducted to consider hazards to personnel, fuels, and ordnance. Resulting recommendations would establish safety exclusion zones to minimize exposures. Safety exclusion zones would also be established to minimize high voltage exposure from generator wiring and cabling. Therefore, no significant health and safety impacts would be expected.	Activation of infrared and optical sensors would not impact health and safety. Safety exclusion zones would be established as required to minimize high voltage exposure from generator wiring and cabling.	Sensor laser beams can be hazardous to the eyes of living organisms within a certain hazard distance. Applicable regulations and procedures, such as establishing restricted areas, displaying warning signs, designating restricted areas, and removing reflective surfaces, would reduce potential health and safety impacts below significant levels. Safety exclusion zones would also be established to minimize high voltage exposure from generator wiring and cabling.
Noise	Noise impacts would be limited to noise produced by generators, which are considered in Support Assets.	Noise impacts would be limited to noise produced by generators, which are considered in Support Assets.	Noise impacts would be limited to noise produced by generators, which are considered in Support Assets.
Transportation	NOTAMs and NOTMARs would provide sufficient warning. Therefore, no significant transportation impacts would be expected.	Activation of infrared and optical sensors would not interfere with transportation. Therefore, no significant transportation impacts would be expected.	Activation of laser sensors would not interfere with transportation. Therefore, no significant transportation impacts would be expected.
Water Resources	Releases of diesel fuel or coolants from support generators into surface water would be diluted rapidly; therefore, no significant impacts to water resources would be expected.	Releases of diesel fuel or coolants from support generators into surface water would be diluted rapidly; therefore, no significant impacts to water resources would be expected.	Liquids used in laser sensor cooling systems are non-hazardous and in the unlikely event of a release would not be expected to impact water resources.
Orbital Debris	Space-based radars could reenter the Earth's atmosphere due to failure; however, most objects break up and vaporize in the upper atmosphere under intense forces and heating during reentry. Even if an object survives reentry, it would most likely land in an ocean area, and the chance of hitting populated land area would be small. Therefore, no significant orbital debris impacts would be expected.	Space-based infrared and optical sensors could reenter the Earth's atmosphere due to failure; however, most objects break up and vaporize in the upper atmosphere under intense forces and heating during reentry. Even if an object survives reentry, it would most likely land in an ocean area, and the chance of hitting populated land area would be small. Therefore, no significant orbital debris impacts would be expected.	Space-based laser sensors could reenter the Earth's atmosphere due to failure; however, most objects break up and vaporize in the upper atmosphere under intense forces and heating during reentry. Even if an object survives reentry, it would most likely land in an ocean area, and the chance of hitting populated land area would be small. Therefore, no significant orbital debris impacts would be expected.

Exhibit ES-9. Summary of Environmental Impacts of Alternative 1 - C2BMC

Resource Area	Computer Terminals and Antennas	Underground Cable
Air Quality	Activation emissions would be limited to generator exhaust. Impacts from generator emissions are considered in Support Assets.	Impacts would be limited to ground disturbances resulting from construction activities. Impacts from ground disturbance are considered in Support Assets.
Airspace	Radio transmission frequencies used by computer terminals and antennas could impact airspace through interference with commercial air traffic control communications. Radio frequency use and testing would be coordinated with the appropriate air traffic control agencies; therefore, no significant airspace impacts would be expected.	Activation of underground cable would not interfere with airspace; therefore, no significant airspace impacts would be expected.
Biological Resources	Biological resources could be impacted by activation activities, but the level of impact would vary based on signal frequency and energy, and the proximity of the source to sensitive environments or specific threatened or endangered species. Radio frequency use and testing would be coordinated with the appropriate resource management agencies; therefore, no significant biological resource impacts would be expected.	Activation of underground cable would not interfere with biological resources. Therefore, no significant biological resource impacts would be expected.
Geology and Soils	Activation of computer terminals and antennas would not interfere with geology and soils. Therefore, no significant geology and soils impacts would be expected.	Impacts to geology and soils would be limited to site preparation activities. Impacts from ground disturbance are considered in Support Assets.
Hazardous Materials and Hazardous Waste	Any hazardous materials or wastes used or generated would be handled in accordance with appropriate regulations. Therefore, no significant hazardous materials and hazardous waste impacts would be expected.	Impacts from hazardous materials and hazardous wastes would be limited to site preparation activities. Impacts from ground disturbance are considered in Support Assets.
Health and Safety	Health and safety impacts would vary based on signal frequency and energy, and the proximity of the source to site personnel or the public. No significant health and safety impacts would be expected.	Potential health and safety hazards would be limited to dust/particulate inhalation, improper chemical handling, and improper use of machinery during site preparation and construction. Impacts from ground disturbance are discussed in Support Assets.
Noise	Noise impacts associated with activation of computer terminals and antennas would be limited to noise produced by generators. Impacts related to generator noise are discussed in Support Assets.	The activation of underground cable would not produce noise that has the potential to impact sensitive receptors.
Transportation	Personnel operating and maintaining computer terminals and antennas would generate traffic as a result of activation. Personnel would be on site only during operating hours and during routine maintenance activities; therefore, no significant transportation impacts would be expected.	Any necessary repairs to underground cable would require excavation of the cable. These activities could result in impacts to transportation through movement of equipment and personnel to the repair site. However, this would occur infrequently, therefore, impacts to transportation would not be significant.

Exhibit ES-9. Summary of Environmental Impacts of Alternative 1 - C2BMC

Resource Area	Computer Terminals and Antennas	Underground Cable
Water Resources	Activation of computer terminals and antennas would not interfere with water resources. Therefore, no significant impacts would be expected.	Impacts to water resources might result from site preparation activities. Impacts from ground disturbance are considered in Support Assets.
Orbital Debris	Space-based computer equipment could reenter the Earth's atmosphere due to failure, but no significant orbital debris impacts would be expected.	N/A

Exhibit ES-10. Summary of Environmental Impacts of Alternative 1 – Support Assets

Resource Area	Support Equipment	Infrastructure	Test Assets
Air Quality	Increased use of support equipment resulting in greater quantities of emissions could impact air quality. The significance of the impact depends on the local and regional regulatory setting and the physical climate where emissions would occur.	Site preparation and construction activities would result in air emissions; however, it is assumed that the impact on air quality would be temporary and localized. Therefore, no significant air quality impacts would be expected.	The development and use of targets, simulants, countermeasures, and drones could impact air quality. Following standard operating procedures would reduce potential impacts to air quality below significant levels.
Airspace	Operational use changes of support assets would not interfere with airspace. Increases in support asset operations would be in accordance with existing airspace use regulations. Therefore, no significant airspace impacts would be expected.	Site preparation and construction would not interfere with airspace. Therefore, no significant airspace impacts would be expected.	Simulants, countermeasures, and their delivery systems (boosters) could impact airspace. Site-specific analyses would be conducted to address these potential impacts.
Biological Resources	Following required scheduling, duration of testing, and completing required agency regulatory agency consultations would reduce potential impacts on biological resources below significant levels.	Site preparation and construction activities could impact biological resources. Site-specific analyses and regulatory agency consultations would be conducted to address these potential impacts.	Potential impacts on biological resources could be associated with debris in which simulants and countermeasures were used. Site-specific analysis would be conducted to address these potential impacts.
Geology and Soils	In general, operational use changes would not be expected to significantly impact geology and soils. Mitigation measures may be used in instances where impacts could occur to reduce impacts to less than significant levels.	Construction would incorporate design parameters consistent with the geologic setting to reduce potential seismic impacts. Construction activities could impact soils; however, Best Management Practices would be implemented to minimize impacts.	Development and use of simulants and countermeasures could impact soils based on the composition of the simulant or countermeasure. Site-specific analyses would be conducted to address potential impacts.
Hazardous Materials and Hazardous Waste	Hazardous waste would be handled and disposed in accordance with appropriate regulations. Therefore, no significant hazardous materials and hazardous waste impacts would be expected.	Hazardous waste would be handled and disposed in accordance with appropriate regulations. Therefore, no significant hazardous materials and hazardous waste impacts would be expected.	Hazardous waste would be handled and disposed in accordance with appropriate regulations. Therefore, no significant hazardous materials and hazardous waste impacts would be expected.
Health and Safety	Standard operating procedures specific to an action or installation would be used and equipment training performed to reduce potential impacts to health and safety.	Standard operating procedures specific to an action or installation would be used and equipment training performed to reduce potential impacts to health and safety.	Standard operating procedures specific to an action or installation would be used and equipment training performed to reduce potential impacts to health and safety.

Exhibit ES-10. Summary of Environmental Impacts of Alternative 1 – Support Assets

Resource Area	Support Equipment	Infrastructure	Test Assets
	Therefore, no significant health and safety impacts would be expected.	Therefore, no significant health and safety impacts would be expected.	Therefore, no significant health and safety impacts would be expected.
Noise	Noise impacts are based on site-specific receptors and are regulated on a regional basis. Site-specific analysis would be conducted for actions that may have noise impacts.	Noise impacts are based on site-specific receptors and are regulated on a regional basis. Site-specific analysis would be conducted for actions that may have noise impacts.	The development and use of simulants or countermeasures would not have noise impacts. The launch and flight of targets would produce noise similar to that of interceptors. However, as described in Exhibit ES-6 no significant noise impacts would be expected.
Transportation	Operational use changes that increase the amount of time that support equipment are used could impact transportation. However, these impacts are not expected to be significant.	Site preparation and construction activities may require the use of heavy machinery and an influx of construction workers which could change the congestion and level of demand for access to the existing roadways. However, these activities would not be expected to cause a significant impact on transportation.	The development and the use of simulants would not impact transportation. Short-term road closures, the issuance of NOTAMs and NOTMARs to notify pilots and mariners of area closures, and debris recovery activities would not be expected to impact transportation.
Water Resources	Operational use changes occurring at existing facilities designed for the support equipment would not impact water resources. Operational use changes that result in impacts to areas not specifically designed for use of the support equipment could be subject to additional environmental review.	Applicable protocols and permits would reduce potential impacts to water resources from construction activities to below significant levels. Site-specific analyses would be conducted for new installations.	The development and use of simulants and countermeasures could impact water resources. Site-specific analyses would be conducted to determine and address impacts.
Orbital Debris	No impacts from orbital debris would occur as a result of the development of new or the major modification of existing equipment or an operational use change of such equipment. Space-based equipment (satellites) could reenter the Earth's atmosphere due to failure, but would not likely result in significant impacts because they would burn up on reentry.	No impacts from orbital debris would occur as a result of the development of new or the major modification of existing infrastructure.	If countermeasures are used and remain on-orbit, they have the potential to disrupt or damage space-based assets (e.g., communication satellites). However, because the debris would be on orbit for a relatively short time it would not have a significant impact on orbiting structures. In addition, only a small amount of debris would survive reentry and therefore no significant impacts are expected.

Test Integration

System Integration Tests would integrate existing and planned components such as sensors, weapons, and C2BMC. Under Alternative 1, test integration activities would involve land-, sea-, and air-based platforms for weapons; and land-, sea-, air- and space-based platforms for sensors, C2BMC, and support assets. Integrated GTs and SIFTs have the potential for environmental impacts, as described in Exhibit ES-6.

For this PEIS, two representative scenarios that could be used during SIFTs were considered for Alternative 1. These two representative scenarios involve similar activities (launches of targets, use of multiple sensors, and use of land-, sea-, and air-based weapons); however, they differ in number of target launches and number of weapons used. Both representative scenarios may be used to support the proposed BMDS and are analyzed in this PEIS. The activities associated with each type of System Integration Tests that were analyzed in this PEIS include

- **Integrated GTs**. The activation of multiple sensors and C2BMC components, and passive activation of weapons (e.g., powering the tracking and communication aspects of the weapons system but not firing the weapon) within the same biome or across several biomes, which would coordinate the control and transfer of information between land-, sea-, and air-based weapons.

- **SIFT Scenario 1- Single Weapon with Intercept**. The activation of multiple sensors and C2BMC components within the same biome or across several biomes coupled with the launch of one target and the activation of a laser or launch of an interceptor, and the debris from an intercept.

- **SIFT Scenario 2- Multiple Weapons with Multiple Intercepts**. The activation of multiple sensors and C2BMC components within the same biome or across several biomes coupled with the launch of up to two targets from the same biome or different biomes, the activation or launch of multiple weapons in the same biome or multiple biomes, and the debris from intercepts.

A summary of potential environmental effects associated with Test Integration for Alternative 1 is provided in Exhibit ES-11. The analyses are specific to each resource area based on the impacts from the activities associated with each test.

Exhibit ES-11. Summary of Environmental Impacts of Alternative 1 - Test Integration

Resource Area	GT	SIFT Scenario 1	SIFT Scenario 2
Air Quality	Emissions from generators used to power sensors and C2BMC would be a small fraction of the *de minimis* threshold and would not impact air quality. The activation of radars, infrared, and optical sensors would not impact air quality.	Emissions from launch activities and laser activation would be less than two percent of *de minimis* thresholds; impacts to air quality would be insignificant.	Impacts to air quality would be insignificant, provided the activity is within parameters of the launch facility or range.
Airspace	Coordination with the FAA Air Route Traffic Control Center (ARTCC), military installations, and foreign countries with jurisdiction over affected airspace would minimize the potential for impact. All laser sensors would be operated using appropriate range safety regulations.	Close coordination with the FAA ARTCC, military installations, and foreign countries with jurisdiction for airspace management would minimize the potential for adverse impacts on airspace use and scheduling. Upon completion of such coordination for each test, there would be no significant impacts to airspace.	Close coordination with the FAA ARTCC, military installations, and foreign countries with jurisdiction over affected airspace would reduce the potential impacts to airspace. Upon completion of such coordination for each test, there would be no significant impacts to airspace.
Biological Resources	Potential impacts to the environment and the threatened and endangered species, the unique or sensitive environments, and the migratory, breeding, and feeding activities would be evaluated in site-specific analyses.	Potential impacts to the environment and the threatened and endangered species, the unique or sensitive environments, and the migratory, breeding, and feeding activities would be evaluated in site-specific analyses.	Potential impacts to the environment and the threatened and endangered species, the unique or sensitive environments, and the migratory, breeding, and feeding activities would be evaluated in site-specific analyses.
Geology and Soils	Fuel spills associated with generators would be controlled and cleaned up according to appropriate procedures; therefore any impacts would be insignificant.	HCl and particulate emissions from interceptor and target launches would not result in significant impacts to geology and soils.	HCl and particulate emissions from interceptor and target launches would not result in significant impacts to geology and soils.
Hazardous Materials and Hazardous Waste	Hazardous materials and waste would be handled according to all applicable regulations, and each test location would have a Spill Prevention, Control and Countermeasure (SPCC) plan in place to handle any spills or leaks of hazardous materials; therefore impacts would be insignificant.	Applicable regulations and procedures would be followed and would prevent impacts from management and disposal of hazardous materials or waste associated with laser activation and target and weapons launches.	Applicable regulations and procedures would be followed and would prevent impacts from management and disposal of hazardous materials or waste associated with laser activation and target and weapons launches.
Health and Safety	All safety procedures would be followed, safety zones would be established, and participating personnel would be trained	All safety procedures would be followed, safety zones would be established, and participating personnel would be trained and certified to reduce the potential for impacts to	All safety procedures would be followed, safety zones would be established, and participating personnel would be trained and certified to reduce the potential for impacts to

Exhibit ES-11. Summary of Environmental Impacts of Alternative 1 - Test Integration

Resource Area	GT	SIFT Scenario 1	SIFT Scenario 2
	and certified to reduce the potential for impacts to health and safety.	health and safety associated with launches of targets and weapons.	health and safety associated with launches of targets and weapons. The increased exposure to health and safety risks associated with SIFT Scenario 2 would not be expected to result in a significant impact.
Noise	Generators would be operated during tests, and sea- and air-based systems typically would not be operated in proximity to sensitive receptors. In general, the increase in noise from multiple generator use within an environment would not be significant.	Noise from launches of targets and weapons and sonic booms would occur in areas away from sensitive receptors, and would not result in significant impacts.	Noise from launches of targets and weapons and sonic booms would occur in areas away from sensitive receptors, and would not result in significant impacts.
Transportation	NOTAMs and NOTMARs would be issued in advance of testing events to allow aircraft and vessels to plan alternate routes to avoid the EMR hazard areas; the impacts would be insignificant.	Closures of roads, airspace, and marine areas would be of short duration and would be considered routine occurrences for launch sites, and issuance of NOTAMs and NOTMARs would allow vehicles to clear the affected areas. Impacts to transportation would be insignificant.	The increase in transportation requirements or any increases in the frequency, duration, or number of transport route closures would not result in a significant transportation impact.
Water Resources	In general, an increase in risk from hazardous materials and hazardous waste spills and an increase in demand for potable water would not result in significant impacts.	Impacts from the deposition of emissions, propellants, and debris into water resources would be dependent on the specific biome and the unique and sensitive water resources that occur in the biome. In general, impacts to water resources from laser activation and launches would not have additive impacts for activities occurring within the same biome.	Site-specific environmental analysis would be completed to evaluate potentially significant impacts. In general, impacts to water resources from laser activation and launches would not have additive impacts for activities occurring within the same biome.

Exhibit ES-11. Summary of Environmental Impacts of Alternative 1 - Test Integration

Resource Area	GT	SIFT Scenario 1	SIFT Scenario 2
Orbital Debris	N/A	Debris created from exoatmospheric intercepts would reenter Earth's atmosphere within a few months. Because the debris would be on orbit for a relatively short time it would not have a significant impact on orbiting structures. In addition, only a small amount of debris would survive reentry and therefore no significant impacts are expected.	Debris created from exoatmospheric intercepts would reenter Earth's atmosphere within a few months. Because the debris would be on orbit for a relatively short time it would not have a significant impact on orbiting structures. In addition, only a small amount of debris would survive reentry and therefore no significant impacts are expected.

Cumulative Impacts

The implementation of the proposed BMDS under Alternative 1 is worldwide in scope and potential application, and only other actions that are international in scope, have been considered for cumulative impacts. Regional or local past, present, or future actions, which may result in cumulative impacts, would be considered during the completion of site-specific NEPA analyses. Worldwide launch programs for commercial and government programs were determined to be actions of international scope that might be reasonably considered for cumulative impacts in this PEIS. Launches contribute to cumulative impacts in areas including ozone depletion, global warming, and orbital debris.

The cumulative impact on stratospheric ozone depletion from BMDS launches would be far less than and indistinguishable from the effects caused by other natural and man-made sources. The estimated emission loads of chlorine from both BMDS and worldwide launches from 2004 to 2014 would account for only 0.5 percent of the industrial chlorine load from the U.S. over the same 10-year period. Therefore, the cumulative impacts to ozone depletion would not be significant.

The cumulative impact on global warming from BMDS launches from 2004 to 2014 would be insignificant compared to other industrial sources (e.g., energy generation using fossil fuel) and activities (e.g., deforestation and land clearing). The BMDS launch emissions load of carbon monoxide (CO) and CO_2 to the troposphere and stratosphere would be only five percent of the emissions load from worldwide launches. However, even when accounting for both BMDS launches and worldwide launches over the 10-year period, the CO and CO_2 load is extremely small compared to emissions loads from other industrial sources, accounting for 3.5×10^{-4} percent of emissions from U.S. industrial sources in just one year. Therefore, the cumulative impacts to global warming would not be significant.

Orbital debris could be produced from BMDS space-based sensors. Orbital debris that remains on orbit could create hazards to orbiting spacecraft and could have impacts upon reentry if the debris reaches the Earth’s surface in large pieces or containing hazardous materials.

Successful flight tests of the BMDS in the exoatmosphere would result in kinetic energy (i.e., hit-to-kill) intercepts that would produce both target and interceptor debris clouds. With the need for increasingly realistic test scenarios, MDA is considering high altitude, high velocity intercept tests. MDA analysis of BMDS flight tests employing ground-launched interceptors shows that the majority (90 to 95 percent) of post-intercept debris reenters the Earth's atmosphere within six hours. A small amount of post-intercept debris may become orbital debris; however, modeling indicates that risk to spacecraft from intercept debris is far lower than the risk posed by existing background debris.

Additional efforts are on-going to determine flight test risks in the space environment and resulting potential impacts on orbiting spacecraft.

The effects of orbital debris on other spacecraft would depend on the altitude, orbit, velocity, angle of impact, and mass of the debris. Debris less than 0.01 centimeter (0.004 inch) in diameter can cause surface pitting and erosion. Debris between 0.01 to 1 centimeter (0.004 and 0.4 inch) in diameter would produce significant impact damage that can be serious, depending on system vulnerability and defensive design provisions. Objects larger than one centimeter (0.4 inch) in diameter can produce catastrophic damage.

Astronauts or cosmonauts engaging in extra-vehicular activities could be vulnerable to the impact of small debris. On average, debris one millimeter (0. 04 inch) is capable of perforating current U.S. space suits.

Proposed BMDS space-based sensor activities would be expected to produce small quantities of orbital debris, primarily explosive bolts and small pieces of hardware. MDA exoatmospheric flight testing may also produce orbital debris. However, because the majority of BMDS activities would occur in Low Earth Orbit (LEO) where debris would gradually drop into successively lower orbits and eventually reenter the atmosphere, the debris would not be a permanent hazard to orbiting spacecraft. As BMDS testing becomes more realistic, there is potential for an increased amount of debris reaching and remaining on orbit. A large portion of this debris would likely not remain on orbit for more than one revolution, and eventually all of the debris would be expected to de-orbit.

Although it cannot be determined with certainty how much orbital debris would be produced from BMDS space-based sensors or intercepts annually, the fact that orbital debris reenters the Earth’s atmosphere on a daily basis, and that this debris has not caused injury or significant property damage on Earth indicates that orbital debris produced by BMDS space-based sensors and potential exoatmospheric intercepts would not pose significant impacts upon reentry. Therefore the cumulative impacts of orbital debris from Alternative 1 are not expected to be significant.

Summary of Environmental Impacts - Alternative 2

This alternative includes the use of interceptors from land-, sea-, air-, and space-based platforms. The impacts associated with the use of interceptors from land, sea, and air platforms would be the same as those discussed for Alternative 1. Therefore, the analysis for Alternative 2 focuses on the impacts of using interceptors from space-based platforms. At this time although MDA has historically conducted research and development efforts on space-based lasers, these efforts have been put on hold as kinetic energy missile technology, which is more promising in the short term, is being pursued.

If Alternative 2 were selected, additional environmental analysis would be required as the technologies intended to be used become more robust. For purposes of impacts analysis for space-based interceptors it was assumed that all manufacturing activities impacts would be the same as those discussed for Alternative 1, therefore, they are not discussed in detail for Alternative 2. Space-based interceptors would be launched on launch vehicles and maintained from platforms similar to other satellites used for DoD and commercial purposes in prescribed orbits around the Earth. The launch vehicles used to insert the weapon platforms into the proper orbit would likely be existing launch vehicles; and therefore, the impacts of the launch would be as described for support assets. A summary of potential environmental effects from Alternative 2 is provided in Exhibit ES-12.

Exhibit ES-12. Summary of Environmental Impacts of Alternative 2 – Weapons[2]

Resource Area	Interceptors	Debris
Air Quality	Emissions from space-based launches would not affect the human environment; therefore, no significant air quality impacts would be expected.	Most space-based interceptors and associated platform debris would be destroyed upon reentry. Some small particles and pieces of debris may serve as reaction sites for chemical reactions in the atmosphere. Due to the infrequency of debris reentry and deorbiting events, no significant air quality impacts would be expected.
Airspace	A space-based interceptor may be directed towards the Earth during intercepts and could impact the use of airspace in the interceptor's designated path. Coordination with the appropriate FAA ARTCC and relevant military installations with responsibility for airspace management would minimize the potential for any adverse impacts to airspace use. Therefore, no significant airspace impacts would be expected.	For controlled reentries, affected portions of airspace would be cleared of aircraft. For uncontrolled reentries, current capabilities and procedures provide a limited ability to predict when and where a particular object would reenter the Earth's atmosphere. Little advance warning could be given to clear airspace in the event of an uncontrolled reentry. However, uncontrolled reentry would occur infrequently and therefore, no significant airspace impacts would be expected.
Biological Resources	Trajectories would be carefully selected such that interceptor debris would impact in a cleared portion of the ocean or military range. It is unlikely that any interceptor debris that survives reentry would impact biological resources and no significant impacts would be expected.	Most interceptor and platform debris would be destroyed upon reentry. The debris would fall to the Earth's surface and likely terminate in open ocean waters, where impact would be limited to animals in the immediate surface waters near the impact point. Fish and marine mammals at lower depths of the ocean would have more time to react to the sound and would be able to avoid the impact area. Therefore, no significant biological resource impacts would be expected.
Geology and Soils	The launch of interceptors from space-based platforms would not impact geology and soils.	Most debris from space-based interceptors or platforms would likely not survive reentry; surviving debris would likely be very small in size. Therefore, no significant impacts would be expected to geology and soils from space-based debris.
Hazardous Materials and Hazardous Waste	The launch/flight of space-based interceptors would not produce hazardous waste that would be transported to or disposed of on Earth. Therefore, no significant hazardous material and waste impacts would be expected.	Debris contaminated with hazardous materials would be exposed to high temperatures during reentry, likely rendering the debris inert by the time it reaches the Earth's surface. Debris and deorbited material would not be considered hazardous waste. Therefore, no significant hazardous materials or waste impacts would be expected.

[2] Impacts from Alternative 2 include impacts analyzed under Alternative 1 with the addition of space-based weapons.

Exhibit ES-12. Summary of Environmental Impacts of Alternative 2 – Weapons[2]

Resource Area	Interceptors	Debris
Health and Safety	Trajectories would be selected such that, in the event of an unsuccessful intercept attempt, interceptor debris would impact in the open ocean or in designated land-based areas, which would reduce the potential for impacts to health and safety. Therefore, no significant health and safety impacts would be expected.	Trajectories would be selected such that debris would impact in the open ocean or in designated land-based areas. In the event of an uncontrolled deorbit, debris might hit and injure humans. However, the risk that an individual would be hit and injured by reentering orbital debris is estimated to be less than one in one trillion. Therefore, no significant health and safety impacts would be expected.
Noise	Launch noise from space-based launches would not be audible in the human environment and therefore, no significant impacts would be expected.	The noise produced by large pieces of debris hitting the Earth's surface might cause startle responses in nearby animals and might displace mobile species for a short time. However, as reentering debris would generally be small in size, no significant noise impacts would be expected.
Transportation	Launches from space-based platforms would not impact transportation.	Debris reaching the open ocean would most likely not be recovered. Debris recovery on land would be as described for Alternative 1, and would not have an impact on transportation.
Water Resources	Launches from space-based platforms would not impact water resources.	Debris would be rendered inert due to the high temperatures during reentry. Thus debris impacting in surface water would not impact water resources.

Test Integration

System Integration Tests would integrate existing and planned components such as sensors, weapons, C2BMC, and support assets. Under Alternative 2, System Integration Tests would involve land-, sea-, air-, and space-based platforms for weapons; and land-, sea-, air- and space-based platforms for sensors, C2BMC, and support assets.

The unique activities associated with each type of System Integration Test analyzed in this PEIS under Alternative 2 include

- **Integrated GT**. The use of additional components to control and coordinate the activities of the four weapon platforms (land-, sea-, air-, and space-based).
- **SIFT Scenario 1 – Single Weapon with Intercept**. The launch of interceptors from space-based platforms with an intercept.
- **SIFT Scenario 2 – Multiple Weapons with Multiple Intercepts**. The launch of multiple interceptors from multiple weapon platforms (land-, sea-, air-, and space-based) at up to two targets with intercepts. Under Alternative 2, the analysis assumes that the launch of a space-based interceptor would replace a land-, sea-, or air-based weapon launch or laser activation.

A summary of potential environmental effects associated with Test Integration for Alternative 2 is provided in Exhibit ES-13. The analyses are specific to each resource area based on the impacts from the activities associated with each test.

Exhibit ES-13. Summary of Environmental Impacts of Alternative 2 - Test Integration

Resource Area	SIFT Scenario 2[3]
Air Quality	If an interceptor launch from a space-based weapon replaced an interceptor launch from a land- or sea-based weapon, a reduction in ground level emissions would occur. If the activation of an air-based weapon were replaced, then a reduction in emissions would occur in the upper atmosphere. Impacts to air quality would be less than those for Alternative 1.
Airspace	If the flight path of a space-based weapon is limited to the exoatmosphere, then the impacts to airspace would be less than those for Alternative 1. If the flight path of a space-based weapon is directed toward Earth in the endoatmosphere, then the impacts to airspace would be similar to those for Alternative 1.
Biological Resources	Interceptor launches from space-based weapons would result in fewer impacts on Earth from noise and pollutant emissions. The impacts to biological resources for Alternative 2 would be less than those for Alternative 1.
Geology and Soils	If a land-based launch is replaced by a space-based launch, then the impacts to geology and soils would be less for Alternative 2 than those for Alternative 1. If a sea- or air-based launch is replaced by a space-based launch, then the impacts to airspace would be similar to those for Alternative 1.
Hazardous Materials and Hazardous Waste	Under Alternative 2, there would be a reduction of hazardous materials use, and hazardous waste generation associated with the launch or activation of a weapon. The impacts from hazardous materials and hazardous wastes for Alternative 2 would be less than those for Alternative 1.
Health and Safety	Launching an interceptor from space rather than from land, air, or sea would result in a reduction in the number of individuals that would be exposed to health and safety risks associated with launch activities. Because no significant impacts were identified under Alternative 1 from the increased use and generation of hazardous materials and hazardous waste, no significant impacts would be expected from Alternative 2.
Noise	Noise produced from the launch of interceptors from space-based platforms would not be audible on Earth. Because no significant impacts were identified under Alternative 1 from increased noise, no significant impacts would be expected from Alternative 2.
Transportation	The transportation impacts under Alternative 2 would be the same as the impacts under Alternative 1.
Water Resources	An interceptor launch from a space-based platform would replace an interceptor launch from a land-, sea-, or air-based platform, which would result in a potential reduction in the debris and simulants that would reach a water resource based on elevation where an intercept or flight termination would occur. Impacts to water resources for Alternative 2 would be less than or equal to those for Alternative 1.
Orbital Debris	Increases in orbital debris would be greater under Alternative 2 than under Alternative 1 because a higher proportion of the tests would occur in the exoatmosphere because of testing associated with space-based interceptors. However, 90 to 95 percent of debris created from exoatmospheric intercepts would reenter Earth's atmosphere within six hours. Because the debris would be on orbit for a relatively short time it would not have a significant impact on orbiting structures. In addition, only a small amount of debris would survive reentry and therefore no significant impacts would be expected.

[3] The environmental impacts associated with GTs and SIFT Scenario 1 are not presented by resource area because such impacts were not found to be substantially different from the impacts described for Alternative 1.

Cumulative Impacts

Placing interceptors in space would add additional structures to space for extended periods of time; therefore, it is appropriate to include in this cumulative impacts analysis other programs that are international in scope which place structures in space for extended periods of time. The International Space Station (ISS) was determined to be such a program. Therefore, the cumulative impacts analysis for Alternative 2 encompasses the discussion of worldwide launch programs as discussed for Alternative 1 and includes a discussion of the impacts of the proposed BMDS on and with the ISS.

Because the majority of BMDS activities would occur in LEO where debris would gradually drop into successively lower orbits and eventually reenter the atmosphere, and the orbital debris produced by BMDS activities would be small in size and in amount, orbital debris from BMDS activities would not pose a long-term hazard to the ISS. The National Aeronautics and Space Administration (NASA) and the U.S. Air Force Space Command monitor orbiting space objects and are aware of instances when the ISS is predicted to be in proximity to space debris that has the potential to damage spacecraft. Prior to every BMDS flight test, MDA assesses the risks posed to spacecraft from post-intercept debris. Launch times are selected to preclude any conjunctions between spacecraft and intercept debris. If necessary, additional analysis is conducted to determine safe launch times within launch windows thereby minimizing the risks to spacecraft. This analysis allows MDA to determine when to safely conduct a flight test. Because the proposed BMDS activities would be expected to produce small quantities of debris which would eventually be removed from orbit and because MDA would only use launch windows when the ISS would not be in the debris, there would be no significant impacts expected to the ISS from the implementation of Alternative 2 for the BMDS.

Summary of Environmental Impacts - No Action Alternative

The No Action Alternative involves the continuation of MDA activities to develop and test discrete weapons, sensors, C2BMC, and support assets and would not include System Integration Testing of these components. For the potential sites being considered for BMDS deployment, the No Action Alternative would be a continuation of activities currently occurring or planned at those locations for individual systems. Therefore, the environmental impacts on the various resource areas associated with the No Action Alternative would be the same as the impacts resulting from continued development and testing of individual missile defense elements.

The decision not to deploy a fully integrated BMDS could result in the inability to respond to a ballistic missile attack on the U.S. or its deployed forces, allies, or friends in a timely and successful manner. Further, this alternative would not meet the purpose of or need for the proposed action or the specific direction of the President and the U.S. Congress.

ACRONYMS AND ABBREVIATIONS

ABL	Airborne Laser
ABM	Anti-Ballistic Missile
ACGIH	American Conference of Governmental Industrial Hygienists
ACHP	Advisory Council on Historic Preservation
AFB	Air Force Base
AFRL	Air Force Research Laboratory
ait	atmospheric interceptor technology
ALCOR	Advanced Research Project Agency Lincoln C-band Observable Radar
Al_2O_3	Aluminum Oxide (alumina)
ANSI	American National Standards Institute
AMOS	Air Force Maui Optical and Supercomputing Station
ARS	Active Ranging System
ARTCC	Air Route Traffic Control Center
AWS	Arrow Weapon System
BILL	Beacon Illuminator Laser
BM	Battle Management
BMC2	Battle Management/Command and Control
BMC3	Battle Management/Command, Control and Communications
BMDO	Ballistic Missile Defense Organization
BMDS	Ballistic Missile Defense System
BMEWS	Ballistic Missile Early Warning System
BOA	Broad Ocean Area
BTS	Bureau of Transportation Statistics
^oC	Degrees Celsius
C2	Command and Control
C2BMC	Command and Control, Battle Management, and Communications
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CEQ	Council on Environmental Quality
CFC	Chlorofluorocarbon
CFR	Code of Federal Regulations
Cl	Atomic Chlorine
Cl_2	Molecular Chlorine
CM/CM	Critical Measurements and Countermeasures
CO	Carbon Monoxide
CO_2	Carbon Dioxide
COIL	Chemical Oxygen Iodine Laser
COMSATCOM	Commercial Satellite Communications
CONOPS	Concept of Operations

CTF	Combined Test Force
dB	Decibel
dBA	A-weighted decibel
DNL	Day Night Average Noise Level
DoD	Department of Defense
DOT	Department of Transportation
DRMO	Defense Reutilization and Marketing Office
DSP	Defense Support Program
EA	Environmental Assessment
EIS	Environmental Impact Statement
EKV	Exoatmospheric Kill Vehicle
EM	Electromagnetic
EMR	Electromagnetic Radiation
EO	Executive Order
EPA	Environmental Protection Agency
ESA	European Space Agency
ESG	Engagement Sequence Group
ESQD	Explosive Safety Quantity Distance
ETR	Extended Test Range
EWR	Early Warning Radar
^oF	Degrees Fahrenheit
FAA	Federal Aviation Administration
FBX-T	Forward Based X-Band Radar Transportable
FL	Flight Level
FM	Flight Mission
FR	Federal Register
FTS	Flight Termination System
GBI	Ground-Based Interceptor
GBMC2	Ground-Based Midcourse Command and Control
GBR-P	Ground-Based Radar Prototype
GEO	Geosynchronous Earth Orbit
GHz	Gigahertz
GMD	Ground-Based Midcourse Defense
GT	Integrated Ground Test
H_2	Hydrogen
H_2O	Water
HAA	High Altitude Airship
HAIR	High Accuracy Instrumentation Radar
HALO	High Altitude Observatory
HAP	Hazardous Air Pollutant
HEL	High Energy Laser
HCl	Hydrogen Chloride
ICAO	International Civil Aviation Organization

ICBM	Inter-Continental Ballistic Missile
IDC	Initial Defensive Capability
IDLH	Immediately Dangerous to Life and Health
IDO	Initial Defensive Operations
IDOC	Initial Defensive Operations Capability
IDT	In-Flight Interceptor Communication System Data Terminal
IEEE	Institute of Electrical and Electronics Engineers
IFR	Instrument Flight Rules
IPSC	Interagency Perchlorate Steering Committee
IRFNA	Inhibited Red Fuming Nitric Acid
IRST	Infrared Search and Track
ISS	International Space Station
ISTEF	Innovative Science and Technology Experimentation Facility
KEI	Kinetic Energy Interceptor
KLC	Kodiak Launch Complex
LDC	Limited Defensive Capability
L_{eq}	Equivalent Noise Level
LEO	Low Earth Orbit
LHA	Launch Hazard Area
Lidar	Light Detection and Ranging
LOAEL	Lowest Observed Adverse Effect Level
LOS	Level of Service
MDA	Missile Defense Agency
MDIE	Missile Defense Integration Exercises
MEADS	Medium Extended Air Defense System
mg/m^3	Milligrams per cubic meter
mg/kg	Milligrams per kilogram
MHz	Megahertz
MOA	Military Operating Area
MPE	Maximum Permissible Exposure
MSL	Mean Sea Level
MSSS	Maui Space Surveillance System
MSX	Midcourse Space Experiment
N_2	Nitrogen
NAAQS	National Ambient Air Quality Standards
NASA	National Aeronautics and Space Administration
NEPA	National Environmental Policy Act
NEXRAD	Next Generation Weather Radar
NIOSH	National Institute of Occupational Safety and Health
NFIRE	Near-Field Infrared Experiment
NMD	National Missile Defense
NO_2	Nitrogen Dioxide
NO_X	Nitrogen Oxides

NOA	Notice of Availability
NOAA	National Oceanic and Atmospheric Administration
NOAA Fisheries Service	NOAA National Marine Fisheries Service
NOI	Notice of Intent
NOTAM	Notice to Airmen
NOTMAR	Notice to Mariners
NPDES	National Pollutant Discharge Elimination System
NRC	National Research Council
OCONUS	Outside the Continental United States
OSHA	Occupational Safety and Health Administration
PAC-3	PATRIOT Advanced Capability-3
PAVE PAWS	Position and Velocity Extraction Phased Array Warning System
PEIS	Programmatic Environmental Impact Statement
PEL	Permissible Exposure Limit
ppm	parts per million
PM	Particulate Matter
PM_{10}	Particulate Matter with diameter 10 microns or less
$PM_{2.5}$	Particulate Matter with diameter 2.5 microns or less
PMRF	Pacific Missile Range Facility
RCRA	Resource Conservation and Recovery Act
RfD	Reference Dose
ROD	Record of Decision
RTS	Ronald Reagan Ballistic Missile Defense Test Site
SBIRS	Space-Based Infrared Sensor
SBX	Sea-Based X-Band Radar
SDI	Strategic Defense Initiative
SDIO	Strategic Defense Initiative Organization
SIFT	System Integration Flight Test
SIP	State Implementation Plan
SM	Standard Missile
SO_2	Sulfur Dioxide
SO_X	Sulfur Oxides
SPCC	Spill Prevention, Control and Countermeasure
START	Reduction and Limitation of Strategic Offensive Arms Treaty
STEL	Short Term Exposure Limit
STSS	Space Tracking and Surveillance System
SWPPP	Storm Water Pollution Prevention Plan
THAAD	Terminal High Altitude Area Defense
TILL	Track Illuminator Laser
TLV	Threshold Limit Value
TMD	Theater Missile Defense
TOO	Target of Opportunity

TPS-X	Transportable System Radar
UCAR	University Corporation for Atmospheric Research
U.S.	United States
USAF	United States Air Force
USAKA	U.S. Army Kwajalein Atoll
USFWS	United States Fish and Wildlife Service
U.S.C.	United States Code
USGS	United States Geological Survey
USSR	Union of Soviet Socialist Republics
VFR	Visual Flight Rules
VOC	Volatile Organic Compound
WASP	Widebody Airborne Sensor Platform
WSMR	White Sands Missile Range
XBR	X-Band Radar

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1 PURPOSE OF AND NEED FOR THE PROPOSED ACTION

1.1 Introduction

Pursuant to the National Environmental Policy Act (NEPA) of 1969 as amended (42 United States Code [U.S.C.] 4321, et seq.), the Council on Environmental Quality (CEQ) Regulations for Implementing the Procedural Provisions of NEPA (40 Code of Federal Regulations [CFR] 1500-1508), Department of Defense (DoD) Instruction 4715.9, *Environmental Planning and Analysis*, Presidential Executive Order (EO) 12114, Environmental Effects Abroad of Major Federal Actions, and the applicable DoD military service environmental regulations that implement these laws and regulations, all Federal agencies must consider the environmental consequences when planning for, authorizing, and approving Federal actions. Accordingly, the Missile Defense Agency (MDA) is preparing this Programmatic Environmental Impact Statement (PEIS) to examine the potential for impacts to the environment as a result of the development, test, deployment, and planning for decommissioning activities of an integrated Ballistic Missile Defense System (BMDS).

A PEIS analyzes actions that are broad in scope, occur in phases, and may be widely dispersed geographically. It also creates a comprehensive, global analytical framework that supports subsequent analysis of specific actions at specific locations within the overall system, i.e., tiering. Ranges, installations, and facilities at which specific test activities occur can develop more focused site-specific analyses that tier from this PEIS, thereby reducing analytical requirements and saving resources. This PEIS addresses the BMDS and the development and application of new technologies; evaluates the range of complex programs, architecture, and assets that comprise the BMDS; and provides the framework for future environmental analyses as activities evolve and mature. This PEIS supports the proposed integrated test schedule and considers BMDS deployment and decommissioning activities. This PEIS also considers the cumulative environmental effects that could result from the proposed action.

1.2 Background

In 1955, the United States (U.S.) began to study ways to protect against ballistic missile[1] attack. This study led to the development of the Nike-Zeus System, which accomplished the first successful intercept of a target Inter-Continental Ballistic Missile (ICBM) in 1962. Ten years later, the U.S. and the former Union of Soviet Socialist Republics (USSR) signed the Anti-Ballistic Missile (ABM) Treaty, which limited the development,

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[1] A ballistic missile is a projectile traveling without its own power or guidance (like a bullet once it has been shot from a gun; the bullet travels a ballistic trajectory with only the forces of gravity and the atmosphere's friction acting on it).

testing, and deployment of ABM systems and components.[2] A 1974 amendment to the treaty further limited ABM defense deployment to one site at either an ICBM field or near the respective national capital. In 1975, the SAFEGUARD System, the only U.S. BMDS ever deployed, was activated in North Dakota. The SAFEGUARD System only operated until 1976, when it was deactivated.

In 1983, the Strategic Defense Initiative Organization (SDIO) was established within the DoD to manage and direct the research and testing of advanced technologies applicable to the development of a strategic missile defense system. These research and testing activities were known collectively as the Strategic Defense Initiative (SDI). Initially, the main purpose of SDI research concerned protecting the U.S. from weapons of mass destruction involving multiple ICBM strikes.

After the break up of the USSR and the conflict in the Persian Gulf in the early 1990's, the SDIO was refocused to emphasize protecting theater (i.e., outside the U.S.) operations and defending the U.S. against limited missile attacks (i.e., 200 warheads or less). In January 1991, President Bush described the need to acquire and deploy a Ballistic Missile Defense (BMD) system to protect not only the U.S. but also its forces overseas and its friends and allies. Subsequently, Congress provided guidance and direction to the DoD to redirect research and development for protection against ballistic missiles, regardless of their source, by enacting the Missile Defense Act.[3] In May 1993, the DoD reorganized the SDIO, renaming it the Ballistic Missile Defense Organization (BMDO).

In October 1993, the DoD completed the *Report on the Bottom-Up Review*, which reviewed the need for restructuring programs within the DoD. With respect to BMD, the review recommended the acquisition of a robust Theater Missile Defense (TMD) system[4], combined with the further development, but not the acquisition, of a more limited National Missile Defense (NMD) system. Accordingly, the DoD analyzed the proposed TMD system, its alternatives, and their potential environmental impacts in the 1993 *Final Theater Missile Defense Programmatic Life-Cycle Environmental Impact*

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[2] MDA activities are in compliance with the Reduction and Limitation of Strategic Offensive Arms Treaty (START). Any mention of target ICBMs in this PEIS refers to decommissioned ICBMs.

[3] The Missile Defense Act enacted as part of the National Defense Authorization Act of 1992 (Public Law 92-190) established goals for theater and national missile defenses. It directed the DoD to develop a TMD system for possible deployment at an initial ABM Treaty-compliant site by 1996 or as soon as appropriate technology would allow. In July 1992, Secretary of Defense Cheney outlined a plan for the development and deployment of theater and national missile defenses. In passing the National Defense Authorization Act (Public Law 92-484) of 1993, Congress deleted the dates contained in the Act and in the conference report accompanying this Act; Congress endorsed a plan to deploy a limited NMD system by 2002.

[4] A theater missile is defined as "any missile (e.g., ballistic, cruise, or air-to-surface guided missile) directed against a target in an area of operations outside the U.S." (*Final Theater Missile Defense Programmatic Life cycle Environmental Impact Statement* 1993) The purpose of TMD is to "prevent or counter the launch of theater missiles against U.S. forces and allies, protect U.S. forces and allies from missiles launched against them, reduce the probability of and minimize the effects of damage caused by such an attack, and manage a coordinated response to a theater missile attack and integrate it with other combat operations."

Statement (TMD PEIS) and in the 1994 *Theater Missile Defense Extended Test Range Environmental Impact Statement* (TMD ETR EIS). The TMD PEIS included analysis of the environmental impacts of the research, development, and testing of TMD systems as well as the later life cycle phases of the system, such as production, basing, and decommissioning. The TMD ETR EIS included analysis of the environmental impacts of conducting extended-range TMD missile demonstration and operational test flights, target intercept tests, and sensor tests.

By 1994, the BMDO believed that the definition of an NMD system, as well as the technologies and resources required to implement the system, were sufficiently well understood to allow for a programmatic analysis of environmental impacts. Therefore, the BMDO issued a BMD PEIS that evaluated the environmental impacts of alternatives that would provide the U.S. the capability to produce and deploy an NMD system in the future. It further examined the cumulative environmental impacts of both the NMD and TMD systems.[5] Although the 1994 BMD PEIS ultimately selected the technology readiness (no action) alternative (i.e., the continuation of ongoing NMD activities and programs initiated under existing Congressional direction that were part of BMDO's technology readiness program) the BMD PEIS also analyzed several systems acquisition alternatives.[6] These alternatives, which involved more intensive research, development, and system-level testing as part of a program to acquire a specific defense system, included various combinations of ground-based and/or space-based elements (e.g., sensors, interceptors, and systems management tools).

Unlike the preferred technology readiness alternative, the system acquisition alternatives evaluated in the BMD PEIS had defined system architectures and descriptions of system acquisition life cycle phases. Thus, for those alternatives, the BMD PEIS evaluated potential environmental impacts of NMD activities beyond development and testing including: system production, fielding (deployment), operations and maintenance, and eventual decommissioning of facilities. The BMD PEIS programmatic analysis of the system acquisition alternatives would support "decisions on research, development, and testing activities" and thus would also serve "as the foundation from which future environmental documentation can be prepared, if needed."

On February 16, 1996, the DoD completed another review of its BMD program. At that time, the DoD began an NMD Deployment Readiness program that would involve a shift

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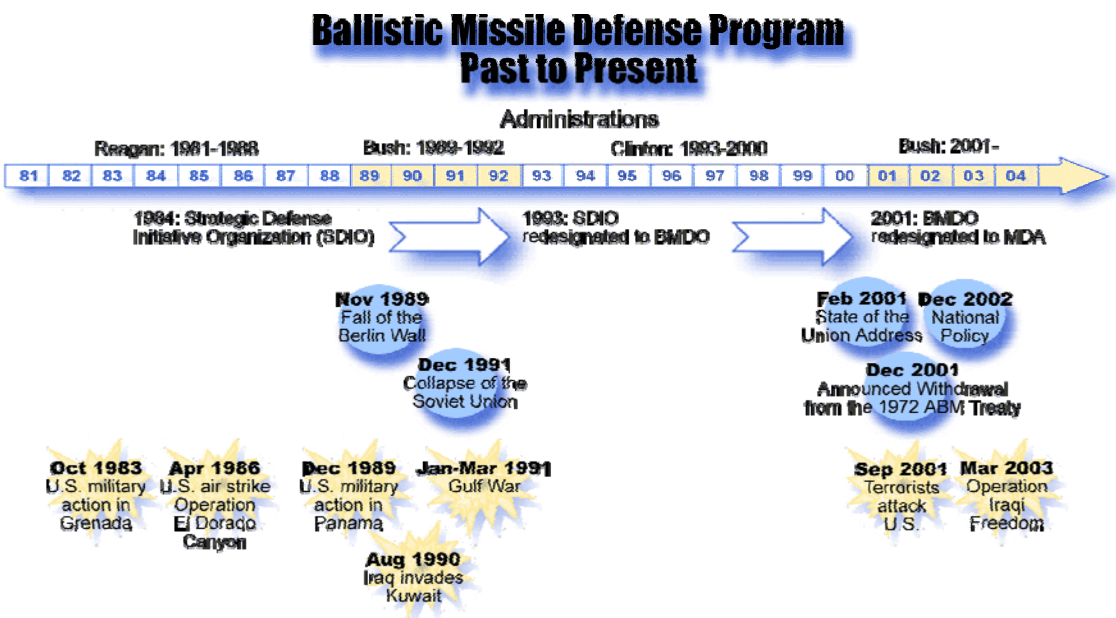
[5] The BMD PEIS focused more intensively on NMD because the DoD determined that the TMD program had independent utility and had already completed the TMD PEIS in 1993. The DoD incorporated the TMD PEIS by reference into the BMD PEIS, however, because the DoD intended TMD and NMD to operate as a multi-layered ballistic missile defense that would commit an appropriate interceptor, whether TMD or NMD, to defend against an attack. The BMD PEIS evaluated the combined effects of the TMD and NMD programs in a cumulative impacts analysis.

[6] Record of Decision (ROD) for the Final Programmatic Environmental Impact Statement (PEIS) for the BMD Program signed April 25, 1995.

from a technology readiness to a deployment readiness program, but without a decision to deploy an NMD system at that time. Therefore, DoD adopted a "3 plus 3" program for NMD, which would have enabled the U.S. to develop, within three years, elements of an initial NMD system that could be deployed within three years of a deployment decision. The DoD expected an NMD three-year development phase, which commenced in 1997, to culminate in a deployment readiness review in the year 2000, at which time the DoD would have decided whether to begin a three-year program to deploy an NMD system. An overview of the major events in the BMDS timeline is depicted in Exhibit 1-1.

Exhibit 1-1. Ballistic Missile Defense Timeline



On July 15, 1998, the "Commission to Assess the Ballistic Missile Threat to the United States"[7] issued a report to Congress. The report unanimously concluded that there had been concerted efforts by a number of overtly or potentially hostile nations (including North Korea, Iran, and Iraq) to acquire ballistic missiles with biological or nuclear payloads, posing a growing threat to the U.S. The report concluded that these nations would be able to inflict major destruction on the U.S. within approximately five years of a decision to acquire such a capability (10 years in the case of Iraq). The report also concluded that the threat to the U.S. posed by these emerging capabilities was broader, more mature, and evolving more rapidly than had been reported in estimates and reports by the Intelligence Community and that ultimately, the U.S. might have little or no

[7] The Commission's mandate was to "assess the nature and magnitude of the existing and emerging powers to arm ballistic missile with weapons of mass destruction." Members of the Commission were nominated by Congressional leaders and appointed by the Director of the Central Intelligence Agency.

warning before operational deployment.[8] For these reasons, the Commission unanimously recommended that "the analyses, practices, and policies" of the U.S. "that depend on expectations of extended warning of deployment be reviewed and, as appropriate, revised to reflect the reality of an environment in which there may be little or no warning."

On November 17, 1998, the BMDO published in the *Federal Register* (FR) a Notice of Intent (NOI) "to prepare an EIS for a potential NMD deployment, should the U.S. Government make such a decision."[9] The BMDO, in July 2000, issued the final Environmental Impact Statement (EIS) for NMD deployment. The proposed action identified in the final EIS was a decision to deploy and operate an NMD system consisting of five elements, including: 1) ground-based interceptors (GBIs)[10]; 2) Battle Management/Command and Control (BMC2)[11]; 3) an X-band radar (XBR)[12]; 4) an upgraded early warning radar (EWR)[13]; and 5) space-based satellite detection systems.[14] The final NMD Deployment EIS further specified that as part of a program to deploy an NMD system, a "Test, Training, and Exercise Capability" would be implemented.

In October 1999, while the draft NMD Deployment EIS was being circulated for public comment, the BMDO successfully completed its first test involving a planned intercept of

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[8] The Commission's report also unanimously determined that the Intelligence Community's ability to provide timely and accurate estimates of ballistic missile threats was eroding and that the warning times the U.S could expect for new, threatening ballistic missile deployments were decreasing.

[9] 63 FR 63915 (1998). In the notice, the BMDO identified the technological elements of the NMD system that would be analyzed in the EIS and stated

> "The decision to be made is whether to deploy such a system. This decision will be based on an analysis of the potential limited strategic ballistic missile threat to the U.S. from a rogue nation, technical readiness of the NMD system for deployment, and other factors including potential environmental impacts. If the decision is to deploy, then sites would be selected from the range of locations studied in the EIS. The EIS will provide the U.S. Government with the information necessary to properly account for the environmental impacts of this decision."

As the BMDO further explained

> "[s]hould the deployment options not be exercised in the year 2000, improvements in NMD system element technology would continue, while an ability to deploy a system within three years of a decision would be maintained."

[10] The GBI's mission is to intercept incoming ballistic missile warheads outside the Earth's atmosphere (exoatmospheric) and destroy them by the force of the impact alone, i.e., without explosives or nuclear warheads. The GBI element includes the interceptor (i.e., missile), kill vehicle, and associated launch and support equipment, silos, facilities, and personnel.

[11] BMC2 is a sub-component of Command, Control, Battle Management and Communications (C2BMC) that supplies the means to plan, select, and adjust missions and courses of action.

[12] The XBRs would be ground-based, multi-function radars that, for NMD purposes, would perform tracking, discrimination, and kill assessments of incoming ballistic missile warheads.

[13] Early warning phased-array surveillance radars, for example, "Position and Velocity Extraction Phased Array Warning System (PAVE PAWS)," are used to detect, track, and provide early warning of sea-launched ballistic missiles. These radars also are used to track satellites and space debris.

[14] Existing DoD satellites provide the U.S. early warning satellite capability. These satellites are comparatively simple, inertially fixed, geosynchronous earth orbit (GEO) satellites with an unalterable scan pattern.

an ICBM.[15] The test demonstrated "hit-to-kill technology" to intercept and destroy the ballistic missile target. The next two tests, which were conducted in January 2000 and July 2000, respectively, did not result in an intercept.

On September 1, 2000, President Clinton announced that, due to technical uncertainties, unsuccessful flight tests, and concerns about potential implications for the ABM Treaty, he would not authorize deployment of an NMD system but would leave that decision to his successor.[16] In the interim, President Clinton stated the DoD would continue developing and testing radars and interceptors that would defend the U.S. against incoming ballistic missiles.

In early 2001 with the election of George W. Bush as President, the BMDO began to expand the test infrastructure to support greater realism in the test program and restructured the development approach into one that adopted spiral development of technologies and capabilities in coherent, incremental blocks.[17] Elements of the BMDO began development of a "test bed" in the Pacific to support this effort.[18]

Because the ABM Treaty limited the development, testing, and development of ballistic missile defense capabilities, President Bush gave Russia formal notice on December 13, 2001 that the U.S. would withdraw from the ABM Treaty in six months. On January 2, 2002, Secretary of Defense Rumsfeld issued a directive to the DoD to establish a single development program for all the work needed to design, develop, and test elements of an integrated BMDS that would operate under a newly titled MDA.[19]

To support test bed activities, MDA completed the *Ground-Based Midcourse Defense Validation of Operational Concept Environmental Assessment* (GMD Validation of

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[15] Exoatmospheric Reentry Vehicle Interceptor System Environmental Assessment (EA), 1987, analyzed the launch of a Minuteman target from Vandenberg Air Force Base (AFB) and the launch of a GBI from the Ronald Reagan Ballistic Missile Defense Test Site (RTS), Kwajalein Atoll.
[16] On May 20, 1999 Congress passed the National Missile Defense Act to "deploy as soon as is technologically possible an effective NMD system..."
[17] "Spiral development" is an iterative process for developing the BMDS by refining program objectives as technology becomes available through research and testing with continuous feedback between MDA, the test community, and military operators. Thus, MDA can consider deployment of a missile defense system that has no specified final architecture and no set of operational requirements, but which will be improved incrementally over time. Blocks are synchronized sets of capability developments that can be added to the BMDS, build on previous blocks, and will be verified prior to transfer to the military services.
[18] "Test bed" is defined as a collection of integrated BMD element development hardware, software, prototypes, and surrogates, as well as supporting test infrastructure (e.g., instrumentation, safety/telemetry systems, and launch facilities) configured to support realistic development and testing of the BMDS.
[19] The MDA's mission is to develop, test and prepare for deployment a missile defense system. Using complementary interceptors; land-, sea-, air-, and space-based sensors; and battle management, command and control, and communications systems, the planned missile defense system will be able to engage and negate all classes and ranges of ballistic missile threats. The Secretary directed that MDA "employ a BMDS that layers defenses to intercept missiles in all phases of their flight (i.e., boost, midcourse, and terminal) against all ranges of threats."

Operational Concept EA) to construct test bed assets at Fort Greely, Alaska and at other supporting Alaska locations.[20] The GMD Validation of Operational Concept EA primarily examined ground activities regarding the construction of six GBI silos and support facilities to validate the operational concept of the test bed. The GMD Validation of Operational Concept Supplemental EA further analyzed additional infrastructure requirements necessary to support validation of the test bed operational concept.[21]

In July 2003, MDA completed the *Ground-Based Midcourse Defense Extended Test Range Environmental Impact Statement* (GMD ETR EIS), which provided for the construction and operation of additional launch and communication facilities in the Pacific test bed, and for development and operation of a sea-based X-band radar (SBX).[22]

Following continued test bed development and successful flight test activities, President Bush decided to provide the nation with an operational missile defense capability. On December 17, 2002, the President announced his decision to field an initial defensive operation (IDO) capability.[23] The initial fielding would provide a modest protection of the U.S. and would be improved over time. In view of this decision, MDA issued a Record of Decision (ROD) from the 2000 NMD Deployment EIS to support the fielding of up to 40 GBI silos at Fort Greely, Alaska.[24] In addition, the IDO capability would include four silos at Vandenberg Air Force Base (AFB). This latter action was addressed in the *Environmental Assessment for GMD Initial Defensive Operations Capability (IDOC) at Vandenberg Air Force Base (AFB).*[25]

Prior to initiation of this PEIS, MDA and its predecessor agencies prepared several programmatic NEPA documents regarding ballistic missile defense.[26] In addition, each program element prepared extensive NEPA documentation to cover its own specific, tiered documents. Ballistic missile defense has again evolved to the point that this programmatic EIS is being prepared to consider the coordinated BMDS as envisioned by the January 2002 creation of the MDA.

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[20] The GMD Validation of Operational Concept EA Finding of No Significant Impact was signed in April 2002.

[21] The GMD Validation of Operational Concep*t* Supplemental EA Finding of No Significant Impact was signed in January 2003.

[22] The GMD ETR EIS addressed dual GBI and target capabilities at Vandenberg AFB, the RTS, Kwajalein Atoll, and the Kodiak Launch Complex (KLC) in Kodiak, Alaska. It further addressed necessary infrastructure in the Pacific to support these capabilities. There have been two RODs for actions analyzed in this EIS: 1) *ROD to Establish a GMD ETR*, dated August 2003, and 2) *Supplemental ROD to Conduct Target Launches from Kodiak Launch Complex in Support of GMD ETR,* dated November 2003.

[23] In October 2004, MDA achieved a limited missile defensive capability (LDC) when certain BMDS test components could also be placed on alert and used in defensive operations. As decisions are made based on technical performance, maturity, military utility, and national security, assets may be "placed on alert" as operational defensive capabilities. These defensive capabilities may initially be limited but could become more robust as more capability is developed or acquired.

[24] The *ROD To Establish a GMD Initial Defensive Operations Capability (IDOC) at Fort Greely, Alaska*, was finalized April 2003.

[25] The GMD IDO Capability at Vandenberg AFB Finding of No Significant Impact was signed in October 2003.

[26] The most recent programmatic documents were the 1993 TMD PEIS and the 1994 BMD PEIS.

1.3 Purpose of the Proposed Action

The purpose of the proposed action is to incrementally develop and deploy a BMDS, the performance of which can be improved over time, that layers defenses to intercept ballistic missiles of all ranges in all phases of flight.

1.4 Need for the Proposed Action

The proposed action is needed to protect the U.S., its deployed forces, friends and allies from ballistic missile threats.

In 1972, only eight countries had ballistic missiles; today there are over 30 and the threat is pervasive and proliferating. The U.S. national policy for addressing the threat of ballistic missiles and weapons of mass destruction includes a dual-path approach of both diplomatic and military measures. Diplomatically, the U.S. tries to assure our allies that we will be a dependable and strong partner for our collective security and also to dissuade or prevent potential adversaries from acquiring or developing ballistic missiles and related technologies altogether. The second path would require a non-offensive, BMDS that would protect the U.S. and its friends and allies from short-, medium-, and long-range threats.

1.5 The Proposed Action

The MDA proposes to develop, test, deploy and to plan for related decommissioning activities for an integrated BMDS using existing infrastructure and capabilities, when feasible, as well as emerging and new technologies, to meet current and evolving threats from ballistic missiles. The Secretary of Defense assigned the MDA the mission to develop and field an integrated BMDS capable of providing a layered defense for the homeland, deployed forces, friends, and allies against ballistic missiles of all ranges in all phases of flight.

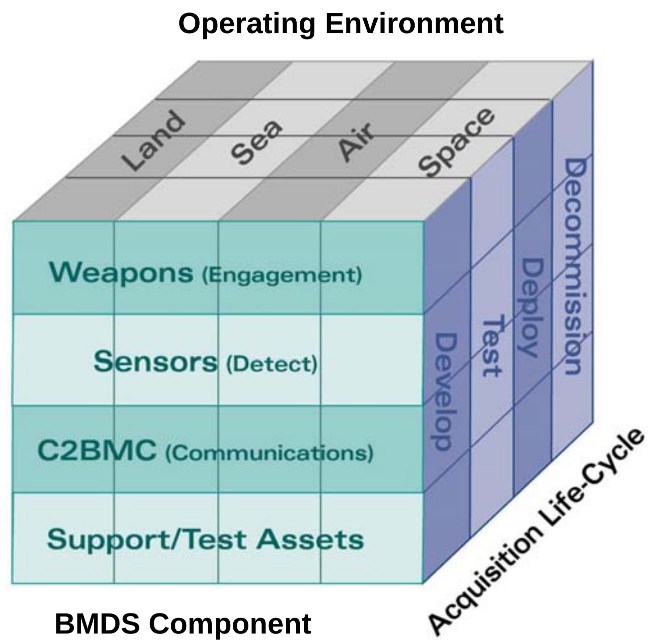
1.6 Scope of the Programmatic Environmental Impact Statement

This PEIS identifies, evaluates and documents, at the programmatic level, the potential environmental effects of the development, testing, and deployment of a BMDS, along with planning for its eventual decommissioning. Although there is already extensive environmental analysis for many of the existing and projected components of the proposed BMDS, this PEIS examines potential environmental impacts of MDA’s concept for developing an integrated BMDS, based on current Congressional and Presidential direction. The BMDS PEIS will provide the framework for analyzing the development, testing and deployment of the range of complex components, architectures, and assets comprising the proposed BMDS, as well as planning for their decommissioning. The BMDS PEIS considers cumulative environmental effects that could result from the

proposed action at an appropriate programmatic level. This framework also will provide a basis from which to tier environmental impact analyses for future MDA activities.

This PEIS will address the life cycle of the proposed BMDS and its components from original research and development through planning for decommissioning. Conceptually, the BMDS is envisioned to be a layered system of weapons (i.e., interceptors and lasers), sensors (i.e., radars, infrared, optical and lasers), Command and Control, Battle Management, and Communications (C2BMC), and support assets (i.e., equipment, infrastructure and test assets), each with specific functional capabilities, working together to defend against all classes and ranges of threat ballistic missiles in the boost, midcourse, and terminal flight phases. Exhibit 1-2 depicts the multi-dimensional complexities

Exhibit 1-2. Complexities of the BMDS



involved in considering the impacts of implementing an integrated BMDS in terms of its components, acquisition life cycle activities, and operating environments.

There currently are no final or fixed architecture and no set operational requirements for the proposed BMDS. Instead, development, demonstration, and deployment of the integrated BMDS would occur over several years in an evolutionary, spiral development process designed to field an initial capability in 2004-2005 and gradually replace, enhance, or supplement this with layers of increasingly capable weapons and sensors, made possible by emerging technologies. Each new technology would go through development; promising technologies would go through testing and demonstration; and proven technologies would be incorporated into the BMDS.

Development includes the various activities that would support research and development of the BMDS components and the overall system. Development activities would include planning, budgeting, research and development, systems engineering, site preparation and construction, maintenance and sustainment, manufacture of test articles (prototypes) and initial testing, and tabletop exercises. Tabletop exercises would be used to develop and improve the Operations Concepts, the broad outline or overall picture of BMDS operations. This PEIS addresses technologies that currently are in the development stage and provides a framework for evaluating new technologies that may be developed in the future.

Testing of the BMDS involves demonstration of BMDS components through test and evaluation. The successful demonstration of the BMDS would rely on a complex testing program aimed at producing credible test data for system characterization, verification, and assessment. To confirm these capabilities, MDA would continue to develop a Test Bed using existing and new land-, sea-, air- and space-based assets. Some construction at various geographic locations would be required to support infrastructure and assets where BMDS components and the overall system would be tested. The BMDS PEIS includes ongoing and planned tests (e.g., ground tests [GTs] and flight tests) of components that might be incorporated into the BMDS, as well as tests of the layered, integrated BMDS through increasingly complex System Integration Tests including system integration flight tests (SIFTs) through 2010 and beyond.

Deployment of the BMDS refers to the fielding (including the manufacture, site preparation, construction and transport of systems) and sustainment (operations and maintenance, training, upgrades, and service life extension) of BMDS architecture. The evolving BMDS is intended to have the capability over time to deploy different combinations of interoperable sensor suites, weapons, and C2BMC. After production, some BMDS components would be transported to deployment locations. Deployment also would involve the transfer of facilities, elements, and programs to the military services. The BMDS PEIS includes start up and ongoing operations and maintenance activities that would be required at the facility locations. For some technologies and fixed assets, such as large radars, proposed deployment locations can be identified. For other technologies, such as mobile launchers and the Airborne Laser (ABL), potential deployment locations can be anticipated only in a general sense, as actual deployment decisions would depend on future geopolitical conditions and security concerns. Although the operational life of some BMDS technologies can be estimated, it is difficult to estimate for many proposed technologies given both the uncertainty of their development and deployment schedules as well as the potential for technology upgrades and service life extensions.

Decommissioning would involve the demilitarization and final removal and disposal of the BMDS components and assets. Plans would be made for decommissioning BMDS components by either demolition or transfer to other uses or owners.

Typical activities involved in developing, testing, deploying and planning for decommissioning the proposed BMDS are identified in Exhibit 1-3.

Exhibit 1-3. Typical Activities for BMDS Proposed Action

Life Cycle Phase	Components	Typical Activities
Development	**Weapons - Laser** **Weapons - Interceptor** **Sensors** **C2BMC** **Support Assets - Equipment** **Support Assets - Infrastructure** **Support Assets - Test Assets**	Planning/Budgeting
		Research and Development
		Systems Engineering
		Site Preparation and Construction
		Maintenance or Sustainment
		Manufacturing of Prototypes
		Testing of Component Prototypes
		Tabletop Exercises
Testing*	**Weapons - Laser**	Manufacturing
		Site Preparation and Construction
		Transportation
		Activation
	Weapons - Interceptor	Manufacturing
		Site Preparation and Construction
		Transportation
		Prelaunch
		Launch/Flight
		Postlaunch
	Sensors	Manufacturing
		Site Preparation and Construction
		Transportation
		Activation
	C2BMC	Manufacturing
		Site Preparation and Construction
		Transportation
		Activation
	Support Assets - Equipment	Manufacturing
		Operational Changes
		Site Preparation and Construction
		Transportation
	Support Assets - Infrastructure	Site Preparation and Construction
	Support Assets - Test Assets	Manufacturing
		Site Preparation and Construction
		Transportation

Exhibit 1-3. Typical Activities for BMDS Proposed Action

Life Cycle Phase	Components	Typical Activities
		Activation
		Prelaunch
		Launch/Flight
		Use of Countermeasures, Simulants, or Drones
		Postlaunch
Deployment	**Weapons - Laser** **Weapons - Interceptor** **Sensors** **C2BMC** **Support Assets - Equipment** **Support Assets - Infrastructure** **Support Assets - Test Assets**	Manufacturing
		Site Preparation and Construction
		Transportation
		Prelaunch
		Launch/Flight
		Postlaunch
		Activation
		Maintenance or Sustainment
		Upgrades
		Training
		Use of Human Services
		Service Life Extension
Decommissioning	**Weapons - Laser** **Weapons - Interceptor** **Sensors** **C2BMC** **Support Assets - Equipment** **Support Assets - Infrastructure** **Support Assets - Test Assets**	Demilitarization
		Disposal

*Includes System Integration Testing that includes integrated GTs as well as system integration flight tests (SIFTs) with a single weapon with single intercept scenario and a multiple weapons with multiple intercepts scenario.

1.7 Consultations and Coordination

As the lead agency, MDA has primary responsibility for preparing the PEIS. As part of the scoping process, the lead agency is required to consult with affected Federal, state, local, and tribal agencies, and other interested parties. A continuing relationship with affected and interested entities can be established to promote cooperation and resolution of mutual land-use and environment-related problems, and to promote the concept of

regional ecosystem management as well as general cooperative problem solving. The agencies involved in this process are referred to as coordinating or consulting agencies.

Consulting agencies do not enter into a legal agreement with the lead agency. Consulting agencies may submit comments and provide data to support the environmental analysis, but they do not participate in the internal review of documents, issues, and analyses. A consulting agency does not participate directly in the development of technical analyses and conclusions.

The MDA has identified several agencies that may be coordinating or consulting agencies for this PEIS. These agencies include: National Oceanic and Atmospheric Administration National Marine Fisheries Service (NOAA Fisheries Service), the Advisory Council on Historic Preservation (ACHP), U.S. Fish and Wildlife Service, and the U.S. Federal Aviation Administration (FAA).

A cooperating agency is any Federal agency, other than a lead agency, that has jurisdiction by law or special expertise with respect to any environmental impact involved in a proposal (or reasonable alternative) for legislation or other major Federal action significantly affecting the quality of the human environment. (40 CFR Part 1508.5) The MDA has held informal meetings with several agencies; however, MDA has not requested that any agencies participate as cooperating agencies for this PEIS. See Appendix A for additional information on consultation and coordination.

1.8 Summary of the Public Involvement Process

The MDA provided several opportunities and means for public involvement during scoping and throughout the preparation of the BMDS PEIS. The CEQ implementing regulations for NEPA describe the public involvement requirements for agencies (40 CFR 1506.6). Public participation in the NEPA process not only provides for and encourages open communication between the MDA and the public, but also promotes better decision-making. Throughout the preparation and review of the Draft BMDS PEIS, the MDA aimed to obtain meaningful input concerning the issues that should be addressed.

1.8.1 Scoping

Scoping for the development of the BMDS PEIS began with the publication of the NOI in the FR (68 FR 17784) on April 11, 2003. See Appendix B for a detailed description of scoping and a copy of the NOI. During scoping, the MDA invited the participation of Federal, state, and local agencies, Native American Tribes, environmental groups, organizations, citizens, and other interested parties to assist in determining the scope and significant issues to be evaluated in the BMDS PEIS. The MDA developed a web site, http://www.mda.mil/mdalink/html/mdalink.html, to provide information on the BMDS PEIS and to solicit scoping comments. The MDA also established toll-free phone and

fax lines, an e-mail address, and a U.S. postal service mailbox for submittal of public comments and questions.

MDA held public scoping meetings in accordance with CEQ regulations. (40 CFR 1501.7) Meetings took place in Arlington, Virginia on April 30, 2003; Sacramento, California on May 6, 2003; Anchorage, Alaska on May 8, 2003; and Honolulu, Hawaii on May 13, 2003. The purpose of the scoping meetings was to request input from the public on concerns regarding the proposed activities as well as to gather information and knowledge of issues relevant to analyzing the environmental impacts of the BMDS. The public scoping meetings also provided the public with an opportunity to learn more about the MDA's proposed action and alternatives. In addition to announcing the public scoping meetings in the NOI, the MDA placed legal notices in local and regional newspapers and notified state governors, mayors, members of Congress and local media representatives about the scoping meetings. See Appendix B for additional information on public involvement.

During scoping, the MDA received 285 comments. The MDA requested scoping comments be submitted by June 12, 2003, to be considered in developing the Draft BMDS PEIS. The majority of comments were related to opposition to the BMDS, especially with regard to the use of space as a weapons platform; concern that the program would bankrupt the economy and that Federal funds should be channeled to address socioeconomic problems, better health care and insurance coverage, and education; and concern that the BMDS would create an arms race, especially in space. Other key issues included opposition to development of nuclear weapons and concern that missile defense could be a first strike capability for U.S. worldwide military domination. Public comments concerning DoD policy, budget, and program issues are outside the scope of the Draft BMDS PEIS. Comments received pertaining to reasonable alternatives to the proposed action, resource areas, human health, and environmental impacts were considered in this BMDS PEIS. See Appendix B for comment excerpts related to resource areas and human health and environmental impacts.

1.8.2 Public Comment Period

The public comment period began with the publication of the Notice of Availability (NOA), published in the FR by the Environmental Protection Agency (EPA) on September 17, 2004. The NOA announced the availability of the Draft PEIS, initiated the public comment period for the NEPA process, and requested comments on the Draft PEIS. The MDA also published a NOA in the FR on September 17, 2004, which provided information on the proposed action and alternatives, listed the dates and locations of the public hearings, and provided contact information for submitting comments to the MDA. See Appendix B for a detailed description of the public comment period and a copy of the NOA.

A downloadable version of the Draft PEIS was available on the BMDS PEIS web site and hardcopies of the document were placed in the following public libraries:

- Anchorage Municipal Library, 3600 Denali Street, Anchorage, AK 99503
- Mountain View Branch Library, 150 South Bragaw Street, Anchorage, AK 99508
- California State Library, Library and Courts Building, 914 Capital Mall, Sacramento, CA 95814
- Sacramento Public Library, 828 I Street, Sacramento, CA 95814
- Hawaii State Library, Hawaii Documents Center, 478 South King Street, Honolulu, HI 96813
- University of Hawaii at Manoa, Hamilton Library, 2550 The Mall, Honolulu, HI 96822
- Arlington County Public Library, Central Branch, 1015 North Quincy Street, Arlington, VA 22201
- District of Columbia Public Library, Central Branch – Martin Luther King, Jr. Memorial Library, 901 G Street, NW, Washington, DC 20001

MDA held public hearings in Arlington, Virginia on October 14, 2004; Sacramento, California on October 19, 2004; Anchorage, Alaska on October 21, 2004; and Honolulu, Hawaii on October 26, 2004. In addition to announcing the public hearings in the NOA, the MDA placed legal notices in local and regional newspapers and notified state governors, mayors, and members of Congress. See Appendix B for additional information on the public hearing notification process.

The purpose of the public hearings was to solicit comments on the environmental areas analyzed and considered in the Draft PEIS. Appendix B contains a reproduction of the transcripts of the public hearings.

During the public review period, the MDA received approximately 8,500 comments on the Draft PEIS. See Appendix K for an overview of comments received on the Draft PEIS and the MDA's responses to in-scope comments. Additional areas of analysis—orbital debris, perchlorate, and radar impacts to wildlife—are addressed in more technical detail in Appendices L, M, and N, respectively.

1.9 Related Documentation

Existing relevant NEPA analysis and health and safety documentation is incorporated by reference. These documents are listed in Appendix C, Related Documentation. The relevant information and analyses contained in these documents is summarized in this PEIS where appropriate.

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2 DESCRIPTION OF PROPOSED ACTION AND ALTERNATIVES

The proposed action is to develop, test, deploy, and to plan for decommissioning activities for an integrated BMDS using existing infrastructure and capabilities, when feasible, as well as emerging and new technologies, to meet current and evolving threats in support of the MDA's mission.

2.1 BMDS Concept

The BMDS is designed to negate threat ballistic missiles of all ranges in all phases of flight. To achieve this mission, the BMDS would be made up of **components** (i.e., weapons; sensors; C2BMC; and support assets). These components would be

> ***Component***: Subsystem, assembly, or subassembly of logically grouped hardware and software, that performs interacting tasks to provide BMDS capability at a functional level.

assembled into programs known as **elements**, which can operate independently or together to defeat a threat missile.

> ***Element:*** A functional set of integrated components comprising a stand-alone defensive capability**.** The elements provide "blueprints" for some of the specific functional capabilities that would be included in the proposed BMDS. However, the configuration of these elements is dependent upon the ongoing testing and enhancement of their components.

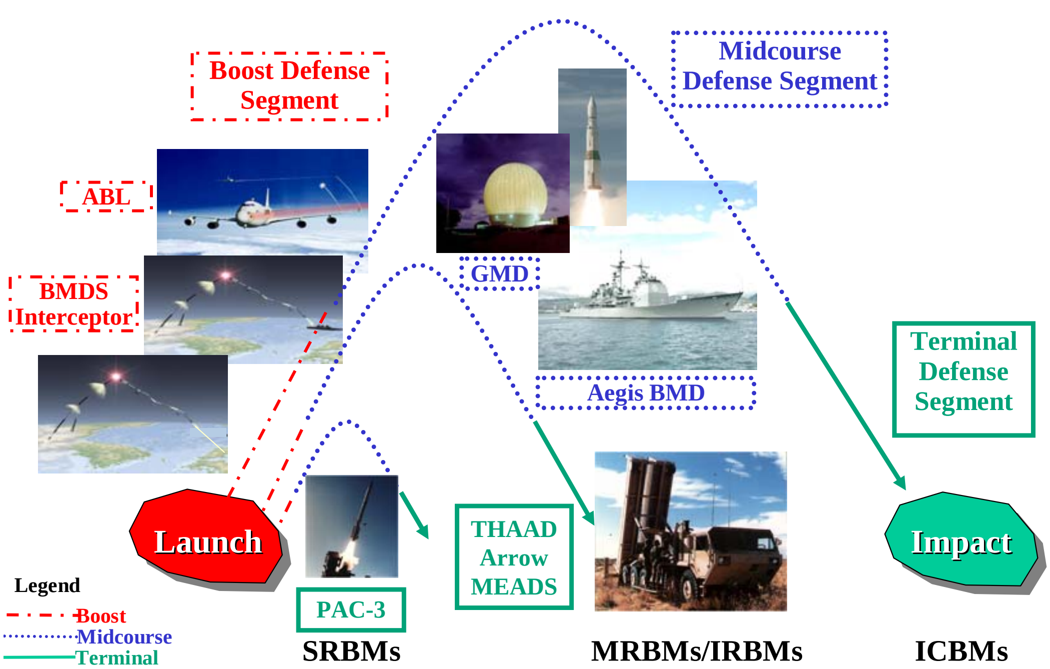
Multiple defensive weapons are required to create a layered defense comprised of multiple intercept or shot opportunities along the incoming threat missile's trajectory. These weapons would be used from a variety of platforms (i.e., any military structure or vehicle bearing weapons). This layered defense would provide a defensive system of capabilities that could back up one another. For example, one element could engage a threat missile in its boost phase and other elements could be used to intercept the threat missile in later phases if initial intercept attempts were unsuccessful. As shown in Exhibit 2-1, ballistic missiles can be categorized based on their approximate flight distances.

Exhibit 2-1. Types and Maximum Ranges of Ballistic Missiles

Type of Ballistic Missile	Approximate Flight Distance in kilometers (miles)
Short Range Ballistic Missile	600 (373)
Medium Range Ballistic Missile	1,300 (808)
Intermediate Range Ballistic Missile	5,500 (3,418)
Inter-Continental Ballistic Missile (ICBM)	10,000 (6,214)

Each type of ballistic missile has three distinct phases of flight: boost, midcourse, and terminal. A flight phase is a portion of the path followed by an object moving through the atmosphere or space. Each phase of flight presents its own challenges to a defensive intercept due to variations in speed, configuration, altitude, and range. The proposed BMDS is envisioned to be capable of defending against all classes of threat ballistic missiles in all phases of flight. Exhibit 2-2 presents missile flight phases also defined as defense segments with the existing BMDS elements designed to operate in them. Please refer to the legend on Exhibit 2-2 to identify the elements that are in the various flight phases or defense segments.

Exhibit 2-2. Ballistic Missile Flight Phases and Defense Segments



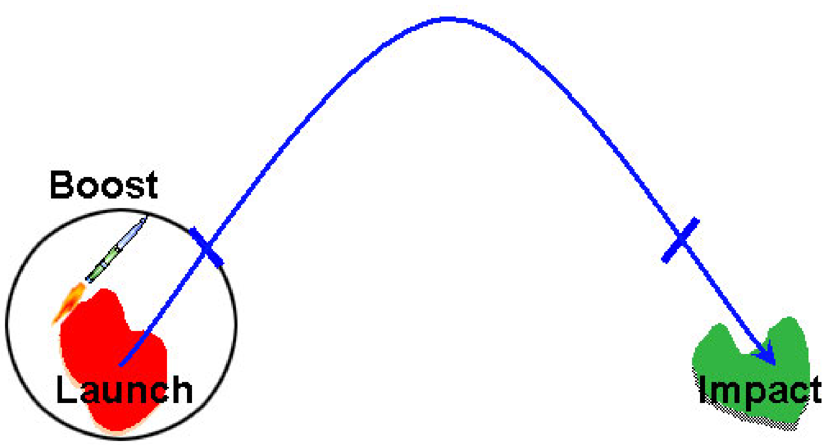
The following section describes each of the three phases of ballistic missile flight, and the currently configured or planned program elements within the BMDS that are designed to address the threat missile within that phase. An overview of the program elements is provided in Appendix D.

2.1.1 BMDS Layered Defense and Missile Flight Phases

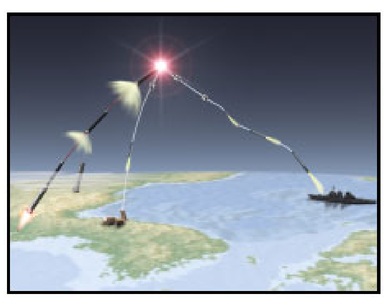
2.1.1.1 Boost Phase and the Boost Defense Segment

The ***Boost Phase*** (see Exhibit 2-3) is the first phase of a ballistic missile trajectory, when the rocket engine is ignited and the missile is lifting off and setting out on a specific path. The missile is powered by its engines throughout this phase.

Exhibit 2-3. Boost Phase and the Boost Defense Segment



Airborne Laser



Terrestrial Test Bed
Kinetic Energy Interceptor

- Ballistic missiles are most vulnerable during boost – relatively easy to find and moving slowly
- BMDS needs to be alerted and positioned near the enemy launch site to engage in boost phase
- Requires quick reaction times, high confidence decision making, and multiple engagement capabilities
- Missile is within Earth’s atmosphere (endoatmosphere)
- Boost phase lasts about 180 to 600 seconds
- Key elements: ABL and Kinetic Energy Interceptor (KEI)

Currently configured or planned BMDS elements in the boost defense segment include

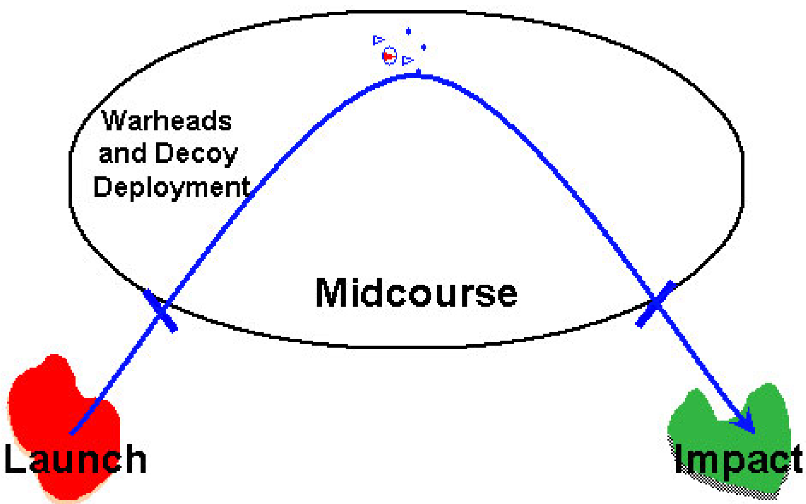
Airborne Laser (ABL). The ABL involves putting a weapons class laser aboard a modified Boeing 747 aircraft and using that laser to destroy enemy ballistic missiles in the boost phase.

Kinetic Energy Interceptor (KEI or BMDS Interceptor). The primary objective of the KEI or BMDS Interceptor program is to develop an interceptor capable of destroying ICBMs in the boost phase.

2.1.1.2 Midcourse Phase and the Midcourse Defense Segment

The *Midcourse Phase* (see Exhibit 2-4) begins when the rocket engine cuts off and the threat missile travels a ballistic trajectory. During this phase, the threat missile is approximately 100 kilometers (62 miles) above Earth's surface. At this point it could deploy decoys to confuse detection and discrimination systems and/or a warhead that continues on the missile's trajectory towards its target.

Exhibit 2-4. Midcourse Phase and the Midcourse Defense Segment



Ground-Based Interceptor Launch

Aegis BMD

- Ballistic missiles "coast" for several minutes during midcourse and may deploy warheads and decoys
- BMDS uses multiple sensors to determine "real" threat and directs weapons to destroy threat objects in space
- Threat missile is about 100 kilometers above the Earth's surface (exoatmosphere)
- Midcourse phase lasts about 1200 seconds
- Key elements: Ground-Based Midcourse (GMD) and Aegis BMD

BMDS elements currently configured to comprise the midcourse defense segment include

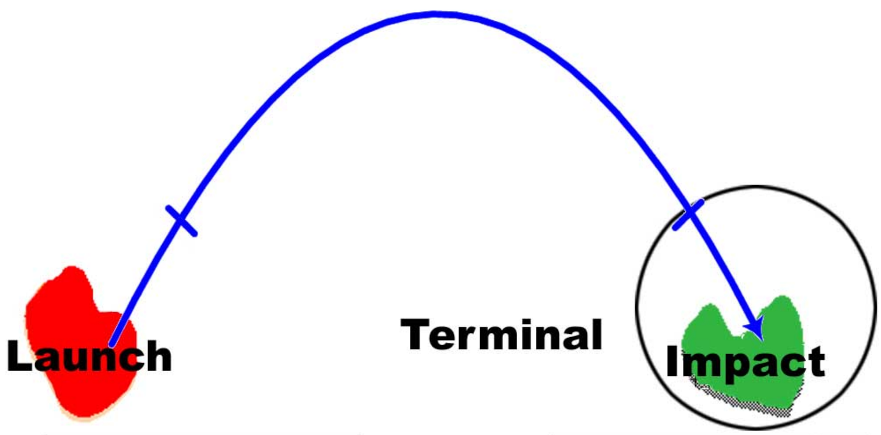
Ground-Based Midcourse Defense (GMD). The GMD mission is to defend against long-range ballistic missile attacks, using its weapon, the GBI, to defeat threat missiles during the midcourse segment of flight.

Aegis Ballistic Missile Defense (Aegis BMD). The Aegis BMD will provide the capability for Navy Aegis cruisers to use hit-to-kill technology to intercept and destroy short- and medium-range ballistic missiles.

2.1.1.3 Terminal Phase and the Terminal Defense Segment

The ***Terminal Phase*** (see Exhibit 2-5) begins as the deployed warhead or the missile continues along its ballistic trajectory towards trajectory termination.

Exhibit 2-5. Terminal Phase and the Terminal Defense Segment



Terminal High Altitude Area Defense (THAAD) Launch

PATRIOT Advanced Capability (PAC)-3

- Ballistic missile is seconds away from its intended target as it approaches trajectory termination
- BMDS “last line of defense” - defensive systems must be positioned near area to be protected (e.g., city, airfield)
- Terminal phase lasts about 30 seconds
- Key elements: PATRIOT Advanced Capability – 3 (PAC-3), Terminal High Altitude Area Defense (THAAD), Israeli Arrow Weapon System, Multi-national Medium Extended Air Defense System (MEADS)

BMDS elements currently configured or planned for the terminal defense segment include

PATRIOT Advanced Capability-3 (PAC-3). PAC-3 is a mobile and transportable land-based missile defense element that is capable of multiple simultaneous engagements of short- and medium-range ballistic missiles and can operate in electronic countermeasure environments.

Terminal High Altitude Area Defense (THAAD). THAAD is designed to destroy a ballistic missile as it transitions from the mid-course to terminal phase of its trajectory both inside and outside of the atmosphere (in the endo- or exoatmosphere). THAAD is a land-based element that has the capability to shoot down a short- or medium-range ballistic missile and has rapid mobility to provide a means of defense anywhere in the world in a short timeframe.

Arrow Weapon System (AWS). The AWS is a cooperative effort between the U.S. and the Government of Israel to develop a missile defense system to protect the State of Israel and U.S. and allied forces deployed in the Middle East Region. The AWS is a ground-based missile defense system capable of tracking and destroying multiple short- and medium-range ballistic missiles in the terminal phase of their flight.

Medium Extended Air Defense System (MEADS). The MEADS program is a transatlantic cooperative effort between the U.S., Germany, and Italy to develop an air and missile defense system that is strategically transportable and tactically mobile. MEADS will defend population centers, vital assets, and forces by countering short- and medium-range ballistic missile threats in the terminal phase of their flight. MEADS will integrate the PAC-3 hit-to-kill interceptor into a system that can move with and protect forces as they maneuver in combat.

2.1.2 BMDS Functional Capabilities

The ability of the proposed BMDS to achieve a layered defense can be described in terms of ***functional capabilities***. The functional capabilities of the BMDS would be developed with the objective of deploying an initial set of capabilities by 2004-2005 and enhancing these capabilities over time.

> ***Functional capabilities***: The capability of the proposed BMDS to detect, identify, track, discriminate, intercept, and destroy a threat ballistic missile during a specific phase of flight (i.e., boost, midcourse, or terminal). Functional capabilities are the abilities to negate specific ballistic missile threats.

The functional capabilities of the proposed BMDS include the long-term flexibility of the BMDS to evolve to meet future threats. To engage a threat, an **engagement sequence** is needed.

> ***Engagement Sequence*:** A unique combination of detect-control-engage functions performed by BMDS components (e.g., sensors, weapons, and C2BMC equipment) used to engage a threat ballistic missile. The command and control, battle management, and fire control functions enable the engagement sequence.

Combinations of these capabilities with common characteristics, called **engagement sequence groups (ESGs)**, may be used to simplify the specification of BMDS capabilities and to more easily assess system performance during testing and operations.

> ***Engagement Sequence Group (ESG):*** The logical categorization of engagement sequences based upon common capabilities or characteristics (e.g., sensors, weapons, and C2BMC equipment) that perform overlapping or similar functions in the execution of an engagement. Using ESGs as a tool enhances functional and engineering analysis, creates manageable combinations for Initial Defensive Operations and Block configurations, simplifies allocation of BMDS capabilities, provides a structure to assess BMDS performance, and assists the warfighter in operating the BMDS.

The BMDS would need to

1. Provide input for missile defense battle management decisions

The BMDS should provide a way to decide when a foreign missile launch poses a threat that warrants a response, what response to take, and when the threat has been negated. The BMDS must be able to obtain the necessary information and provide it to the decision-maker in a timely manner. Functional capabilities needed to provide the information include the ability to

- Detect threat missile launches,
- Determine threat posed by missile (including type of warhead and potential payload),
- Track missile flight path,
- Predict threat impact location(s),
- Communicate with defensive weapons to direct the intercept, and
- Detect/assess the intercept.

2. Negate threat missiles during flight

The BMDS should have the capability to destroy threat missiles anywhere along the flight trajectory. Functional capabilities that the BMDS must have to destroy threat missiles include the ability to

- Launch a defensive weapon,
- Overcome any countermeasures released by a threat missile,
- Guide defensive weapon to critical point,
- Engage threat missile, and
- Negate threat payload.

3. Provide multiple engagement opportunities during flight

The BMDS should provide multiple engagement opportunities along a flight path. Threat missiles evading initial intercept attempts could be negated by subsequent attempts. This capability also provides opportunities to destroy the threat while it is over enemy territory (i.e., during boost) or over sparsely populated areas (i.e., during midcourse flight). Functional capabilities needed to provide multiple engagement opportunities include the ability to

- Coordinate and manage multiple weapon launches,
- Sustain/maintain launch facilities, and
- Engage threat missile in all flight phases.

4. Provide robust defense against evolving threats

The BMDS should have the capability to adjust to a constantly evolving threat environment. Enemies will adjust and develop their offensive tactics and capabilities. Changing political situations may shift where threat missiles may be launched and the theater of operations the BMDS must protect. Functional capabilities that must be developed to defend against evolving threats include

- Interoperable technologies that can work in various combinations, and
- Interoperable technologies that are deployable where needed.

According to the functional capabilities currently identified for the proposed BMDS, the system would detect, identify, track, discriminate, engage, and destroy ballistic missiles in all phases of flight that threaten the U.S. and its deployed forces, allies, and friends. To achieve these functional capabilities, the proposed BMDS would be a system of integrated technologies, or **components,** that are greater than the sum of the current defensive elements. The components of the BMDS are

- Weapons (i.e., interceptors and lasers),
- Sensors (i.e., radars, infrared, optical, and lasers),
- C2BMC, and
- Support Assets (i.e., auxiliary equipment, infrastructure, and test assets).

Individual components can be thought of as “tools” or “building blocks” that could be combined in different ways to meet the required functional capabilities of the proposed BMDS. Components would contribute to the functional capabilities as described in Exhibit 2-6.

Exhibit 2-6. Crosswalk of Functional Capability with Components

FUNCTIONAL CAPABILITY	COMPONENTS			
	Weapons	**Sensors**	**C2BMC**	**Support Assets**
1. Input for Missile Defense Battle Management Decision				
Detect Threat Missile Launches		X		X
Determine Threat Posed by Missile		X	X	X
Track Missile Flight Path		X		X
Predict Impact Location		X	X	X
Communicate with Other Elements and Weapon System	X	X	X	X
Detect/Assess Intercept		X	X	X
2. Negate Threat Missiles During Flight				
Launch Defensive Weapon	X		X	X
Overcome Countermeasures	X	X		X
Guide Weapon to Critical Point	X	X	X	X
Interrupt Missile Flight	X			X
Negate Threat Payload (Lethality)	X			X
3. Provide Multiple Engagement Opportunities During Flight				
Coordinate Multiple Weapon Launches	X	X	X	X

Exhibit 2-6. Crosswalk of Functional Capability with Components

FUNCTIONAL CAPABILITY	COMPONENTS			
	Weapons	**Sensors**	**C2BMC**	**Support Assets**
Engage Threat Missile in All Flight Phases	X	X	X	X
4. Provide Robust Defense Against Evolving Threats				
Interoperability of Components	X	X	X	X
Deployable Where Needed	X	X	X	X

The BMDS functional capabilities would evolve over time in response to newly defined threats and technology developments. As the functional capabilities change, individual components and elements would be enhanced with new technologies to meet those threats. The evolution of the proposed BMDS is described in Section 2.1.3 BMDS System Acquisition Process below.

2.1.3 BMDS System Acquisition Approach

2.1.3.1 Traditional Approach to Missile Defense Acquisition

The system acquisition process for evolving defensive systems historically required defined system architectures. Under the traditional approach, the MDA primarily focused on developing single elements and associated technologies that could provide independent defensive military utility. These stand-alone elements can be characterized as packages of components, typically comprised of sensors, a weapon, accompanying C2BMC hardware and software, and support assets.

The traditional acquisition process focused on developing, testing, and procuring individual elements with certain functional defensive capabilities. However, this process can also require a rigid adherence to a defined life cycle. All components of an element must meet all existing weapons acquisition specific test, development, and operational requirements before the element can be produced and procured. This inflexible process can be redundant and inefficient as technical challenges associated with one component might delay the progress of other components in an element. The initial focus of the DoD on developing and acquiring elements resulted in several NEPA analyses to support the development, testing, and procurement of the proposed defensive elements and their components. Detailed discussions of these elements can be found in Appendix D.

2.1.3.2 New Approach to Proposed BMDS

The MDA, as the acquisition agency for the BMDS, has implemented a new, more flexible approach to developing the proposed BMDS. This approach is capability-driven and component-based rather than focused on specific elements or programs. Capability-based planning allows MDA to develop capabilities and objectives based on technology feasibility, engineering analyses, and the capability of the threat. This development involves an iterative process known as spiral development that refines program objectives as technology becomes available through research and testing with continuous feedback between MDA, the test community, and the military operators. Thus MDA can consider deployment of a missile defense system that has no specified final architecture and no set operational requirements but which will be improved incrementally over time.

MDA’s approach to accomplish the goal of developing an integrated, layered BMDS capable of engaging enemy ballistic missiles of all ranges during the boost, midcourse and terminal phases of flight would focus on

- Fielding an initial defensive capability (IDC) in accordance with the President’s direction;
- Adding interceptors and networked, forward-deployed ground-, sea- and space-based sensors to make the interceptors more effective in 2006-2007; and
- Adding layers of increasingly capable weapons and sensors, made possible by inserting emerging technologies.

The approach for incremental improvement involves

- Determining functional capability needs,
- Identifying potential ways to meet these needs with new and/or enhanced components,
- Using a spiral development process to develop, test, and identify new technologies, and
- Fielding only those new and/or enhanced components with proven ability to meet the identified functional capability needs.

Spiral development begins when a desired functional capability is identified. The ability of existing components and emerging technologies to meet the functional capability would be reviewed and efforts to develop or enhance specific components would be initiated. Testing and ongoing modification would be used to determine the ability of each component to meet the functional capability needs. For example, new components would undergo initial development or proof-of-concept testing, while existing components would be tested to determine their readiness for use. Work on a given technology improvement would stop if testing failed to demonstrate effectiveness or functional capability needs changed.

The process is organized into two-year time windows, or **Blocks**, consisting of packages of capabilities that are being developed over several years. For example, Block 2004 represents years 2004-2005, and Block 2006 represents years 2006-2007. During each Block, the MDA would research, develop, and test components in varying stages of development.

> ***Block***: A block is a two-year increment of the BMDS providing an integrated set of capabilities, which has been rigorously tested as part of the BMDS Test Bed and assessed to adequately characterize its military utility. The configuration for each block is drawn from the prior BMDS Block; BMDS elements, components, technologies, and concepts; C2BMC architecture; and externally managed systems, elements or technologies.

Thus, the development and testing of individual components to meet a specific BMDS functional capability would "spiral" through several successive Blocks (see Exhibit 2-7). When appropriate, spiral development within block increments would help keep pace with useful technology improvements, reduce risk through iterative reviews, and match user expectations with delivered performance to provide improved capabilities as quickly as possible. Eventually, some components would be transitioned to the military service responsible for deployment, operation and maintenance. Evolutionary acquisition in block increments would provide a practical approach to aggressively develop and field early BMDS capabilities while preserving flexibility to respond to evolving ballistic missile threats and incorporate improved technology.

Exhibit 2-7. Block Development Process

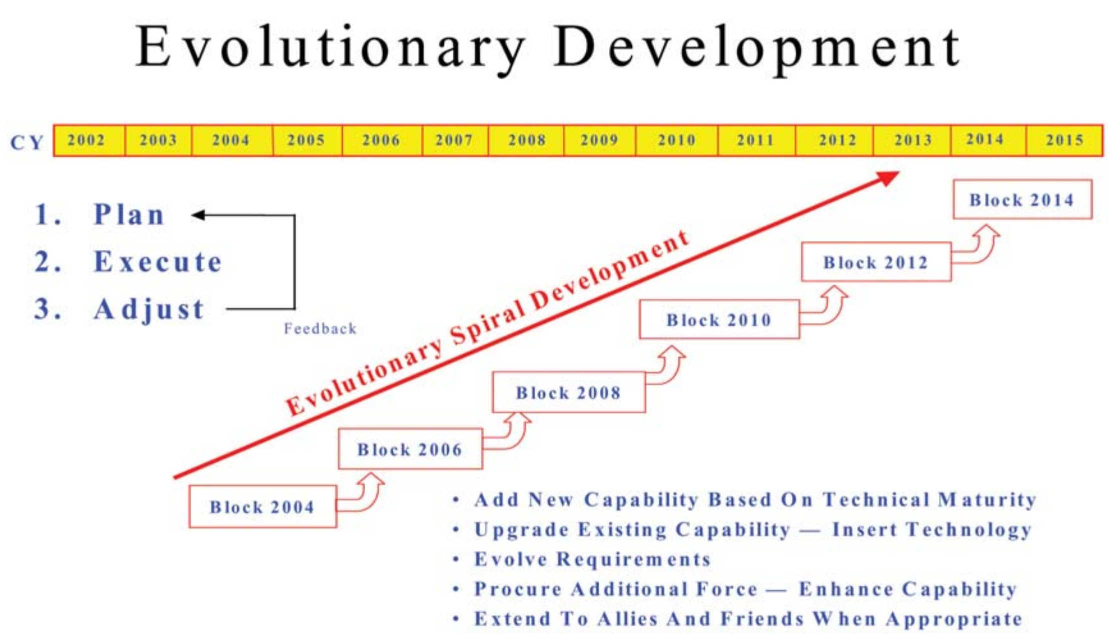
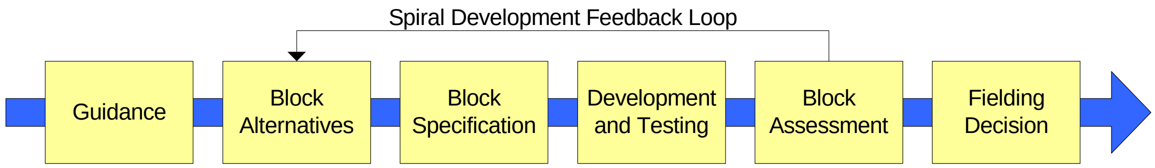


Exhibit 2-8 shows spiral development via the systems engineering process.

Exhibit 2-8. The MDA Systems Engineering Process



The engineering principle for organizing and discussing the BMDS capability is the ESG, which is a means to categorize or group similar engagement sequences based on capability or function. An engagement sequence is a unique combination of detect-control-engage functions performed by BMDS components used to engage a threat ballistic missile; it would define a specific detection sensor, specific fire control radar and specific weapon. ESGs define the sequence of events, functions, and system components used to enable a weapon to engage a target and provide the structure for measuring the level of performance and integration maturity of the BMDS. ESGs also relate multiple ways of engaging a target.

An example of an ESG is an intercept scenario in which the GBI would receive its final target update from the COBRA DANE Radar. As the BMDS grows in complexity, i.e., integration of many elements and components, the number of ESGs will increase, thereby increasing system capability. Better information about the threat from additional sensors and more chances to destroy the threat from additional weapons will also result in enhanced system performance. Using ESG as a tool enhances functional and engineering analysis creates manageable combinations for Block configurations, simplifies allocation of BMDS capabilities, provides a structure to assess BMDS performance, and assists the warfighter in operating the BMDS.

2.2 BMDS Components

The components of the proposed BMDS are weapons, sensors, C2BMC, and support assets that as part of the existing or envisioned elements can provide the functional capabilities of the BMDS. The proposed BMDS would integrate components in a unified system. The general characteristics of these components are described in the following sections. Descriptions of components of existing elements are provided in Appendix D.

2.2.1 Weapons

Weapons are the components of the BMDS that can be used to destroy threat missiles. For the BMDS, weapons consist of various types of interceptors and directed energy weapons (e.g., high energy lasers [HELs]). Interceptors would use two primary kinetic energy technologies, hit-to-kill or direct impact and directed fragmentation.

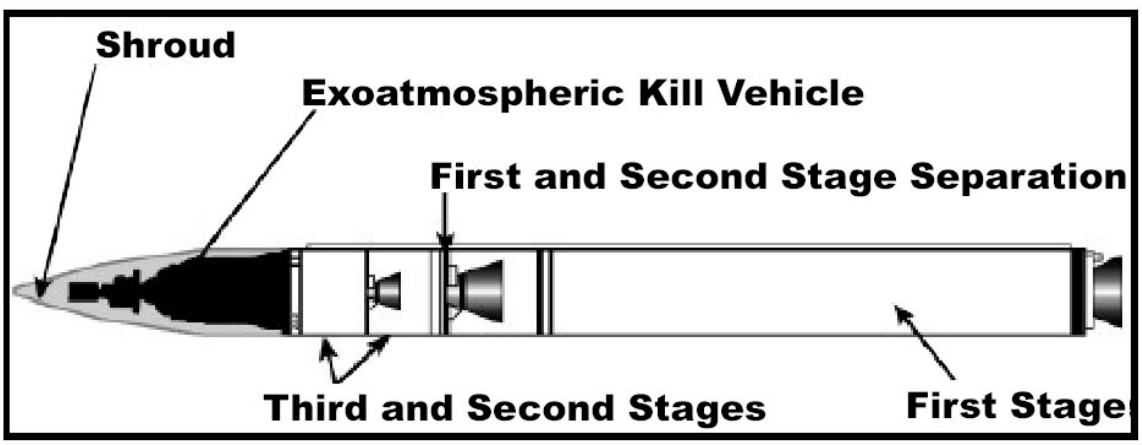
Interceptors must conduct multiple tasks simultaneously, adjust flight path accurately, discriminate the reentry vehicle from countermeasures, and engage and negate the threat missile. BMDS interceptors could be placed on land, sea-, air-, or space-based platforms. BMDS directed energy systems are currently envisioned to perform target illumination and tracking and to negate threat missiles from an air-based platform, although they could also be placed on land-, sea-, or space-based platforms.

2.2.1.1 Weapons Technologies and Subcomponents

Interceptors

Interceptors use kinetic energy either in a direct impact or hit-to-kill mode, or to deflect or possibly destroy a threat missile by directed blast fragmentation. Interceptors are composed of two primary parts, a booster and a kill vehicle (see Exhibit 2-9). An interceptor may have one or more boosters (also called stages). The number of boosters or stages refers to the number of rocket motors that sequentially activate. Multiple stages allow the interceptor to fly at higher velocities and altitudes, and for longer distances. The kill vehicle is the portion of the interceptor that performs the intercept and destroys the threat missile. It is anticipated that solid and liquid propellants would be used in the boosters and in the kill vehicles. For the purposes of this PEIS, interceptors will be discussed and analyzed for environmental impacts at the booster and kill vehicle level. This will allow the MDA the flexibility to configure new interceptors based on boosters and kill vehicles analyzed in this document to address new or emerging threats.

Exhibit 2-9. Interceptor Schematic



Interceptors may also use lethality enhancers, seekers, and attitude control systems. Lethality enhancers are non-nuclear explosive devices that increase the probability of destroying the threat missile and its payload (e.g., explosives, chemical or biological agents). Seekers help to detect the threat missile and home in on it. Attitude controls are small motors used to modify the flight path of the kill vehicle and position it into the

flight path of the threat missile. All of these are important parts of interceptors and the environmental impacts from their use will be considered as part of the analysis of boosters and kill vehicles in this PEIS.

Boosters use two broad classes of propellants: solid and liquid. Propellants consist of a fuel and oxidizer. An oxidizer is a substance such as perchlorate, permanganate, peroxide, and nitrate that yields oxygen readily to support the combustion of organic matter, powdered metals and other flammable material. Boosters can use liquid hydrocarbon propellants (e.g., kerosene) plus an oxidizer such as liquid oxygen; cryogenic propellants (e.g., liquid oxygen or liquid hydrogen [H_2]) where the fuel and oxidizer are maintained at very low temperatures; hypergolic propellants (e.g., hydrazine [fuel] and nitrogen tetroxide [oxidizer]) where mixing the fuel and oxidizer ignites the engine without requiring an external ignition source; or solid propellant (e.g., polybutadiene matrix, acrylonitrile oxidizer and powdered aluminum). Solid rocket motors can also be used as external motors to supplement the thrust of the first stage of an interceptor. Some propellants such as hydrogen peroxide can be used in concentrated form as a monopropellant or in conjunction with other propellants.

Interceptor Technology

As mentioned above there are two major kinetic energy technologies employed by interceptors, hit-to-kill and directed blast fragmentation.

Hit-To-Kill

Hit-to-kill technology relies on high closing speeds of an interceptor to collide with and destroy the threat missile. The interceptor uses kinetic energy, that is, the force of the collision, to destroy the threat warhead. Most of the BMDS elements, e.g., GMD, Aegis BMD, THAAD, and PAC-3, use this interceptor technology. Exhibit 2-10 shows an example of an interceptor launch.

Exhibit 2-10. Interceptor Launch

Directed Blast Fragmentation

Directed blast fragmentation technology involves the interceptor approaching the threat ballistic missile and exploding close to it, thereby disrupting the path of the threat missile and possibly destroying it. The interceptor does not actually collide with the threat ballistic missile. A directed blast fragmentation kill vehicle explodes near the threat missile and distributes its fragments over a large area to create a kill zone around the path of

the threat missile. As the quickly moving threat missile enters the kill zone it collides with the fragments, which alter its path and potentially destroy the threat missile altogether. Arrow and PATRIOT systems currently include this technology.

Lasers

Laser use directed energy to destroy threat ballistic missiles. High mobility and speed-of-light intercept are key aspects of directed energy weapons. The ABL element currently uses this laser technology.

A megawatt class chemical HEL is being developed as part of the BMDS boost phase defense system. HEL devices are laser systems that use high speed flowing gas or large amounts of electrical power, or combinations of the two, to produce directed beams of energy. The chemical oxygen iodine laser (COIL) is one of three lasers under consideration to be integrated into the BMDS. The COIL operates by creating chemical reactions between chlorine gas and a mixture of hydrogen peroxide and alkali metal hydroxides. The chemical reactions produce a form of oxygen (singlet delta) that is used to transfer the energy to atoms of iodine. The iodine, in turn, releases this energy as light, which is then focused by mirrors and lenses into a laser beam. The COIL has four primary parts: oxygen generator, gain generator (or resonator), pressure recovery system, and storage tanks that hold all the chemicals needed to operate the laser. Directed energy from the laser weapon would heat the threat missile body canister causing overpressure and/or stress fracture, which would destroy the missile. The HEL could be mounted on an aircraft and flown at high altitudes to detect, track, and destroy threat missiles in the boost phase.

2.2.1.2 Weapons Basing Platforms

There are four primary weapons basing platforms considered in this PEIS: land, air, sea, and space. Some of the interceptor and laser technologies could be based on more than one type of platform while others might be based on only a single platform. The basing platform for a weapon would affect the impact that the weapon has on the environment. The weapons basing platform may also affect the phase of flight in which the weapon can intercept a threat missile. The description and analysis of the support equipment and infrastructure associated with the fixed weapons basing platforms (e.g., missile silos, launch pads, sled tracks) and the mobile weapons basing platforms (e.g., mobile launchers, aircraft, ships, satellites) are presented under Support Assets, equipment and infrastructure, respectively.

Land-based Platforms

Land platforms would be either fixed or mobile. The fixed land platforms would include missile silos, launch pads, and launch stools from which interceptor missiles could be launched. Sled tracks and engine test stands could be used to test motors for interceptors or conduct GTs of directed energy weapons. Mobile land platforms currently include mobile launchers mounted on trucks or trains and moved into the desired location. The following BMDS weapons would use land platforms: KEI, GBI, THAAD, PAC-3, AWS and MEADS.

Air-based Platforms

Air platforms would include balloons and aircraft of various types and sizes. The ABL is currently the only proposed BMDS element with a weapon using an air platform, i.e., the HEL.

Sea-based Platforms

Sea platforms would be either fixed or mobile. The fixed platforms would include man-made islands or vessels anchored to the sea floor. The mobile platforms would be either self-propelled or moved or towed via a tug vessel. These could include ships, submarines, and other sea-faring vessels (e.g., platforms not anchored to the sea floor). The KEI and the Standard Missile (SM) are currently the proposed BMDS weapons using a sea platform.

Space-based Platforms

Space platforms would carry sensors and/or weapons and would be carried into space by launch vehicles. Once released by the launch vehicle, the space platform would maneuver into the appropriate orbit around the Earth using on-board propulsion systems. The platforms could be maneuvered into several different types of orbits including Geosynchronous Earth Orbit (GEO), which allows the platform to remain positioned over one location on the Earth, and Low Earth Orbit (LEO), which allows the platform to be positioned over various parts of the Earth at different times. The space platforms would maintain their orbit by using on-board propulsion systems for the duration of their useful life. The proposed KEI and space-based lasers are types of weapons that could use a space platform.

2.2.2 Sensors

Sensors are the tools that function as the "eyes and ears" of the BMDS. BMDS sensors would provide the relevant incoming data for threat ballistic missiles. Detailed sensor descriptions can be found in Appendix E. The data from these sensors would travel

through the communication systems of the proposed BMDS to Command and Control (C2) where a decision would be made to employ a defensive weapon such as launching an interceptor. The BMDS sensors would provide the information needed to determine the origin and path of a threat missile to support coordinated and effective decision-making against the threat. Additionally, these sensors would provide data on the effectiveness of the defense employed, that is, whether the threat has been negated.

BMDS sensors would be developed or enhanced to acquire, record, and process data on threat missiles and interceptor missiles; detect and track threat missiles; direct interceptor missiles or other defenses (e.g., lasers); and assess whether a threat missile has been destroyed. These sensors (i.e., radar, infrared, optical, and laser) would include signal-processing subcomponents, which receive raw data and use hardware and software to process these data to determine the threat missile's location, direction, velocity, and altitude. This and other relevant information would then be integrated into planning and controlling intercept engagements through the C2BMC component of the BMDS. For the purposes of this PEIS, the analysis of sensor systems will focus on the emissions power and range of the sensor categories to determine which sensors have the most potential for environmental impacts.

The three general categories of sensors considered in this PEIS include

- **Weapon/Element Sensors**. These sensors are part of the individual weapons and elements and allow them to operate independently from the overall BMDS. An example of this type of sensor is the PATRIOT radar. Although weapon/element sensors are designed for independent utility, they would also have the capability to function as an integrated part of the BMDS both in a testing or deployment scenario. For example, the ABL sensors could serve as forward sensors for the BMDS and could be used during testing to provide target information to midcourse and terminal phase weapon components. Discussion of sensors in this category is found under the individual Weapon/Element discussions in Appendices D and E of this PEIS.

- **BMDS Mission Sensors.** These are radar and optical sensors that are not part of an element but would provide data essential to the functional capabilities of the BMDS. These independent sensors would provide information for missile warning, early interceptor commit, in-flight target updates, and target object maps through the BMDS C2BMC architecture to the BMDS and its components. The MDA would include these existing sensors in testing activities either as part of the BMDS architecture or to evaluate a test of other parts of the BMDS architecture. For example, an EWR, such as the Position and Velocity Extraction Phased Array Warning System (PAVE PAWS), could be used to identify an ICBM target and provide cueing information to a midcourse sensor, such as SBX, to test sensor interoperability.

- **Test Range Telemetry Sensors.** These are the sensor systems used to acquire, record, and process data on targets and interceptor missiles during testing on a test range. They detect and track targets, observe defensive weapons, and assess whether a target has been destroyed. They also support range safety activities by providing test operators with information on whether the range is clear of non-test participants (i.e., recreational boats, private aircraft, etc.) and the test is proceeding within planned parameters. These sensors are not part of the actual BMDS, but are considered part of the BMDS Test Bed. Test range telemetry sensors include fixed sensors at test range facilities and mobile sensors at test range facilities or on ships or aircraft. Mobile sensor capabilities add flexibility for testing while minimizing fixed infrastructure investment. The description and analysis of such sensors are presented under Support Assets - Test Assets.

Sensors can also be described in terms of the technologies employed in the various sensor types as discussed below.

2.2.2.1 Sensor Technologies

The technologies used by the existing and proposed BMDS sensors fit into four basic categories, ***radar***, ***infrared***, ***optical***, and ***laser***, based on the frequency or electromagnetic (EM) energy spectrum used by the sensor.

Radar Technology

Radar, which stands for <u>**RA**</u>dio <u>**D**</u>etection <u>**A**</u>nd <u>**R**</u>anging, typically is an active sensor that emits radio frequency energy toward an object and measures the energy of radio waves reflected from the object. Radars are currently based in land and sea operating environments. Most modern radars operate in a frequency range of about 300 megahertz (MHz) to 30 gigahertz (GHz), which corresponds to a wavelength range of one meter to one centimeter. The time delay in the return signal or echo allows the determination of distance to the object and the change in the frequency of the echo through the Doppler Effect allows the determination of the object’s speed. The Doppler Effect is the shift in frequency resulting from relative motion of an object in relation to, in this case, the radar. Most current radars are mono-static because the transmitter and receiver are collocated. There are also radars with multiple transmitters and multiple receivers in different locations that are called bi-static and multi-static radars based on the number of transmitters and receivers. Exhibit 2-11 summarizes the wavelengths and frequencies of radar bands.

Exhibit 2-11. Radar Band Designations

Band	Wavelength Ranges	Frequency Ranges
High Frequency	100-10 meters (328-33 feet)	3-30 MHz
Very High Frequency	10-1 meters (33-3.3 feet)	30-300 MHz
Ultra High Frequency	1 meter-10 centimeters (3.3 feet-4 inches)	300-3,000 MHz
L band	30-15 centimeters (12-6 inches)	1-2 GHz
C band	15-7.5 centimeters (6-3 inches)	2-4 GHz
S band	7.5-3.75 centimeters (3-1.5 inches)	4-8 GHz
X band	3.75-2.50 centimeters (1.5-1 inches)	8-12 GHz
Ku band	2.5-1.67 centimeters (1-0.66 inches)	12-18 GHz
K band	1.67-1.11 centimeters (0.66-0.44 inches)	18-27 GHz
Ka band	1.11-0.75 centimeters (0.44-0.30 inches)	27-40 GHz
W band	3 millimeters (0.12 inches)	95 GHz
Mm band	-	110-300 GHz

Infrared Technology

Exhibit 2-12. DSP Satellite

Infrared sensors detect the heat energy or infrared radiation from an object. Infrared electromagnetic radiation (EMR) has wavelengths longer than the red end of visible light and shorter than microwaves (roughly between one and 100 microns). The Defense Support Program (DSP) satellite, as shown in Exhibit 2-12, is an example of a space-based infrared sensor (SBIRS) that can detect the heat signature or plume from the launch of a ballistic missile.

Optical Technology

Optical sensors operate in the **visible** range and are generally passive sensors that detect objects or missiles by collecting light energy or radiation emitted from the target in wavelengths visible to the human eye. Specifically, the human eye perceives this radiation as colors ranging from red (longer wavelengths, approximately 700 nanometers) to violet (shorter wavelengths, approximately 400 nanometers). The planned Space Tracking and Surveillance System (STSS) satellites, for example, would have both infrared and optical sensors.

Laser Technology

Laser is an acronym for **L**ight **A**mplification by **S**timulated **E**mission of **R**adiation. Laser sensors use laser energy of various energy levels and frequencies (ultraviolet, visible) to illuminate an object to detect the object's motion. Like radar, a laser-based sensor is an active sensor that sends out laser energy toward an object and then receives a return echo from the object. The time delay in the return signal or echo allows the determination of distance to the object and the change in the frequency of the echo through the Doppler Effect allows the determination of the object's speed. The ABL aircraft uses passive infrared sensors to detect, and laser sensors to illuminate and track threat ballistic missiles.

2.2.2.2 Sensor Operating Environments

The operating environments of the existing and proposed BMDS sensors can be considered in four general categories. **Land-based** sensors may be fixed, located in or on a building, or mobile, located on a vehicle or trailer. **Air-based** sensors are located on platforms that can travel through the air such as airplanes, balloons, and airships. **Sea-based** sensors are located on platforms that travel on water (e.g., ships or a floating platform) or are fixed in water (e.g., a man-made island or platform like an oil platform that is fixed to the seafloor). **Space-based** sensors are located on satellites, which travel in circular or elliptical orbits around the Earth. These satellites can be in several different types of orbits including GEO, which is an orbit at approximately 36,000 kilometers (21,700 miles), synchronized with the Earth's rotation, and LEO, which is an orbit at an altitude of approximately 160 to 1,600 kilometers (100 to 1,000 miles). Weather, communications, and some military satellites, such as DSP satellites, typically use GEO orbits.

The following exhibit outlines many of the current and proposed sensors that would or could be developed to provide the BMDS with the required sensor functionality. Exhibit 2-13 includes the proposed operating environment or current proposed location for each of the sensor types.

Exhibit 2-13. Proposed Sensors, Roles and Operating Environments

Sensor	Primary Function	Operating Environment
ABL Infrared Search and Track (IRST)	Infrared Sensor	Airborne
ABL-Active Ranging System (ARS)	Laser Sensor	Airborne
ABL-Beacon Illuminator Laser (BILL)	Laser Sensor	Airborne
ABL-Track Illuminator Laser (TILL)	Laser Sensor	Airborne
Advanced Research Project Agency Lincoln C-band Observable Radar (ALCOR)	Tracking Radar	Fixed land-based
Aegis SPY-1 Radar	Fire Control Radar	Mobile sea-based
Arrow Fire Control Radar	Warning and Fire Control Radar	Mobile land-based
Forward-Based X-Band Radar Transportable (FBX-T)	Tracking and Discrimination Radar	Mobile land-based
Ballistic Missile Early Warning System (BMEWS)	EWR	Fixed land-based
COBRA DANE	EWR	Fixed land-based
U.S. Naval Ship Observation Island	Radar	Mobile sea-based observation platform
DSP	Infrared Sensor	Space-based
Ground Based Radar Prototype (GBR-P)	Fire Control Radar	Fixed land-based
Innovative Science and Technology Experimentation Facility (ISTEF)	Optical and laser sensors	Land-based sensor experimentation facility
ISTEF Mobile Sensors	Optical and laser sensors	Mobile sensor systems based at ISTEF
Maui Space Surveillance System (MSSS) [a.k.a. AMOS]	Optical Infrared Sensor	Fixed land-based
MEADS Surveillance Radar	Warning and Fire Control Radar	Mobile land-based

Exhibit 2-13. Proposed Sensors, Roles and Operating Environments

Sensor	Primary Function	Operating Environment
PATRIOT Radar	Warning and Fire Control Radar	Mobile land-based
PAVE PAWS Radar	Early Warning Radar	Fixed land-based
SBX	Tracking and Discrimination Radar	Mobile, sea-based platform
STSS	Infrared Sensor	Space-based
SBIRS-High	Infrared Sensor	Space-based
THAAD Radar	Warning and Fire Control Radar	Mobile land-based
Transportable System Radar (TPS-X)	Instrumentation Test Bed Radar	Mobile land-based

2.2.3 Command and Control, Battle Management, and Communications (C2BMC)

C2BMC would provide the rules, tools, displays and connectivity to enable the proposed BMDS to engage threat missiles. C2BMC would be the overall integrator of the BMDS. C2BMC would consist of electronic equipment and software that enable military commanders to receive and process information, make decisions, and communicate those decisions regarding the engagement of threat missiles (see Exhibit 2-14). This would include computer workstations installed in existing infrastructure at certain locations, and may include new fiber optic cable, radios, and satellite communications.

Exhibit 2-14. Typical Command Center

C2BMC would be designed and built to provide war fighters with the capability to effectively plan and execute the MDA's mission. C2BMC would integrate and expand existing capabilities that provide the flexibility to exploit a wide range of tactics, techniques and procedures and BM options. The goal of C2BMC is to achieve seamlessness in a layered defense through coordinated C2 and integrated fire control.

Specifically, C2BMC would receive, process, and display tracking and status data from multiple elements, components and sensors so that local commanders at various locations would have the same integrated operating picture and could make coordinated decisions about deploying weapons. This would allow the central command structure to use the most effective weapons to engage threat ballistic missiles in all flight phases.

The BMDS C2BMC includes three primary parts, Command and Control (C2), Battle Management (BM), and Communications that would operate in an integrated fashion across all BMDS components.

- **C2** would provide a flexible, integrated architecture to plan, direct, control and monitor BMDS activities. C2 would provide decision-aid applications that integrate information and recommendations for defensive options in near real-time to develop the operational war fighting aids required for formulating and implementing informed decisions and reduce decision cycles. This would permit quick redirection and reallocation of assets based on rapidly changing situations and threats. C2 also would integrate the Unified Commands, North Atlantic Treaty Organization and other allies, friends, and other external systems to which C2 would connect.

- **BM** would control the launching or firing of missiles and integrate the kill chain functions (surveillance, detect/track/classify, engage and assess) across the layered defenses (boost, midcourse and terminal). Initially, BM would provide the means for executing preplanned responses by integrating available information to provide near real-time tasking and status. As the BMDS evolves, BM would evolve to provide the user with increased automation, capability, and ability to integrate information from increasingly diverse resources. Advancements in BM are intended to further increase the battle space with continued improvements in tracking and discrimination information, sensor netting, operability with coalition partners, near real time intelligence, battlefield learning and dynamic planning, and integrated BM execution using disparate sensors and firing units.

- **Communications** would allow all BMDS components to exchange data and network with BMDS assets. The goal of BMDS communications is to provide robust networks that manage the dissemination of the information necessary to perform the C2 and BM objectives. The communications networks would seamlessly connect BMDS components and link them with other applicable DoD and non-DoD networks and assets as required. The network infrastructure would make optimal use of existing data and information conduits and protocols.

The long-term development of the C2BMC would begin with planning and monitoring the autonomous operation of elements with stand-alone capability and expand to the centralized and integrated control of the BMDS. Currently, each BMDS element, such as THAAD, PAC-3, or ABL operates or is designed to operate as an autonomous unit, each

with stand-alone capability and with its own BM, C2 and communications system (i.e., element-specific BMC3). C2BMC would fuse the data of these BMC3 components by integrating communications to provide a more robust picture of the operational arena. Individual element weapon system component descriptions can be found in Appendix D.

For example, a BMDS element like the PAC-3 has an internal or organic BMC3 component that transfers needed data from its data-gathering sensors (e.g., satellites and radars) to its local military commander. Using the information, the local military commander can make a BM decision to launch a weapon at the incoming threat ballistic missile. The BMDS C2BMC would capture and display tracking and status data from multiple existing and proposed weapon systems' BMC3 systems and sensors so that local commanders at various locations would have the same integrated operating picture and could make coordinated decisions about deploying weapons. C2BMC would include existing and new land-, sea-, air- and space-based C2BMC systems.

In an integrated BMDS, C2BMC would ensure interoperability with other BMDS components in reacting to the threat. For example, if an ABL sensor identifies the presence of an incoming ballistic missile, the information would be transmitted to the BMDS C2BMC. In coordination with other incoming information across the BMDS, a decision could be made that an Aegis cruiser launching a Standard Missile-3 (SM-3) would be the most effective element to engage and negate the threat missile. The commander of the cruiser would have real-time knowledge of the decision to quickly launch an SM-3 interceptor against the threat missile.

The MDA plans to improve the internal BMC3 capabilities of each BMDS element and to develop and continually upgrade the overall BMDS C2BMC. New or additional sensors and communications nodes would be incorporated, as well as new target discrimination algorithms, as they are developed.

Various U.S. command centers would eventually house a C2BMC node. A node is a set of equipment and processes that performs the communications functions at the end of the data links that interconnect those elements, which are resident on the networks. C2BMC nodes are located at geographically dispersed facilities and receive and display tracking and status data from multiple BMDS components so that local commanders can make coordinated decisions about deploying weapons. Each node consists of electronic equipment, software, computer workstations, radios, fiber optic cables, and communication devices. Nodes at various locations integrate and communicate data using this hardware and software to support C2 and BM activities. Each of these nodes would receive and display the same data to local commanders so that they can make coordinated decisions about weapons use.

2.2.4 Support Assets

Support assets are comprised of auxiliary equipment, infrastructure, and test assets that facilitate BMDS operations. Some of the support equipment (e.g., tracking stations and data processing systems) and infrastructure (e.g., test ranges and launch facilities), and all test assets comprise the BMDS Test Bed. They enable BMDS components to operate at maximum effectiveness over an extended useful life. Assets that support BMDS components include mobile equipment, such as cooling systems, power generators, and operator control units as well as fixed infrastructure such as docks and shipyards, launch facilities, airports and air stations, and communication facilities. Support assets as described above will be analyzed separately from their associated component.

Test assets used for component and system testing and deployment purposes include mobile equipment, infrastructure, and other equipment (e.g., target missiles). Although these test assets are not components of the BMDS, they are critical to its effective development and demonstration. Typical test assets would include test range facilities, targets, countermeasure devices, test sensors, optical and infrared cameras, computers, and observation vehicles (e.g., aircraft, ship, trucks, etc.). These test assets are designed to simulate a threat missile in a realistic environment and to assess and enhance the performance of BMDS components in negating those threats.

2.2.4.1 Equipment

The MDA would use a variety of equipment to support the functioning of BMDS components. Interceptors may require generators, fuel tanks, lightning protection, and security surveillance systems. Some weapons elements have mobile launchers such as the THAAD’s modified M-1120 Heavy Expanded Mobility Tactical Truck-Load Handling System Palletized Load System launcher, as presented in Section 2.2.1.2, Weapons Basing Platforms. Support equipment for the ABL includes chemical transfer and recovery receptacles to capture laser chemicals from the aircraft and cooling systems for the laser. Existing aerospace ground equipment at each air base would be utilized where possible to support the ABL aircraft, as needed (e.g., generator to run the aircraft's electrical system). Sensors require antenna equipment units, electronic equipment units, cooling equipment units, and prime power units. These units are housed on separate trailers interconnected with power and signal cabling, as required.

Mobile assets also may include trucks, telemetry vans, personnel trailers, rail cars, aircraft, ships, ocean tugs or barges. For each testing event or deployment location, the MDA would use these vehicles to transport the component, test assets (i.e., targets, sensors, telemetry, etc.), and personnel to the site.

2.2.4.2 Infrastructure

Infrastructure that supports the functions of BMDS components includes docks, shipyards, rocket and missile launch facilities, airports/air stations, and communication facilities. These facilities serve as a base of operation from which components begin their missions and return for maintenance, repair, or storage. The MDA would use existing facilities to the extent possible to minimize the need for new construction. Specific types of facilities that would support the BMDS are discussed below.

Docks and Navy Bases

Sea-based components (e.g., Aegis BMD configured ships, mobile launch platforms, transportable telemetry stations) would operate from existing U.S. Navy bases near deployment locations, and possibly other Federal, state and local assets if required. Sea-based platforms for sensors (e.g., SBX platform, mobile launch platform) would be launched from a base and transported to deployed locations at sea. Periodically, the platform would return to primary support base for repairs, maintenance, or upgrades. The operation of the SBX platform has been considered in the GMD ETR EIS.

Launch Facilities and Ranges

The MDA would use existing launch facilities like those at Cape Canaveral Air Station, the National Aeronautics and Space Administration's (NASA's) Kennedy Space Center and Wallops Flight Facility, Vandenberg AFB and the Kodiak Launch Complex (KLC) to launch test and defensive operational assets into orbit. As appropriate, test launch activities could also take place from these facilities. The MDA activities at these launch facilities would be the same as those for other non-BMDS launches at a DoD or NASA launch facility. Other test ranges, e.g., White Sands Missile Range (WSMR), Pacific Missile Range Facility (PMRF), Ronald Reagan Ballistic Missile Defense Test Site (RTS), etc., would continue to be used for various test events involving interceptor and/or target launches. These ranges and facilities comprise the BMDS Test Bed.

Airports and Air Stations

The MDA would use existing military airports and air stations as a base for operation of airborne components including airborne sensors and weapons. The suite of MDA airborne sensors would be installed and operated in modified civilian and military aircraft, which have the capability to land and takeoff from any large airport. The aircraft would use both contractor and military facilities. Hangars and maintenance facilities at the home air base would be used to maintain the airborne sensors.

Communication Facilities

The MDA would use the existing communication facilities (e.g., C2BMC nodes, transmission towers, and repeaters) located at existing military service installations, launch facilities, ranges, air stations, and on other federally owned or leased property. BMDS development, testing, and integration might require the modification of existing communication facilities, or the construction of new communication facilities within or outside such areas.

2.2.4.3 Test Assets

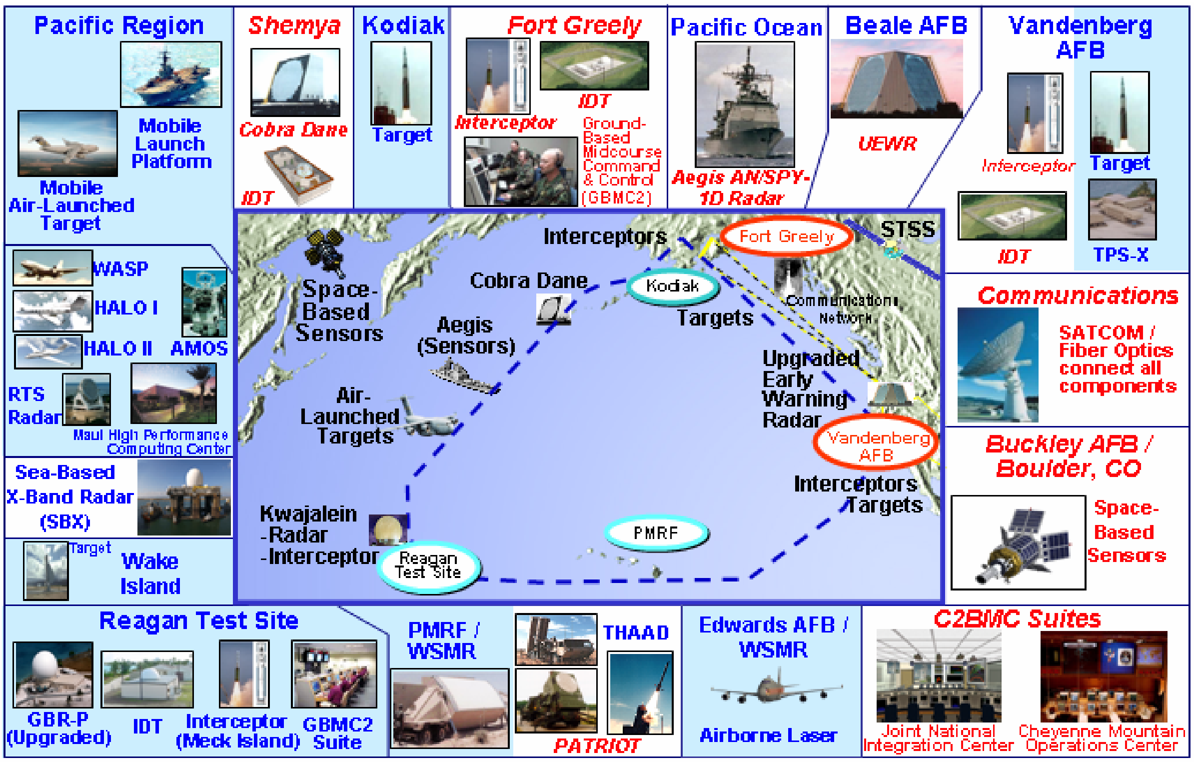
Test assets are not components of the BMDS but are support assets critical to its effective development and testing. Typical test assets would include test range facilities that make up the BMDS Test Bed, sensors used only for test purposes, targets, countermeasure devices, and warhead simulants. Test assets are designed to enhance the BMDS by simulating a threat missile in a realistic environment and to assess the performance of BMDS components in negating those simulated threats. The development and use of countermeasures and simulants in the BMDS test program are part of MDA's Measurement Program as identified in Section 2.2.5. In analyzing impacts of implementing the BMDS in Section 4, countermeasures and simulants will be considered as part of the test portion of the acquisition life cycle as part of Support Assets – Test Assets.

Test Bed

The BMDS Test Bed encompasses the infrastructure and environment where testing takes place. It provides a collection of integrated development hardware, software, prototypes, and surrogates, as well as supporting test infrastructure (e.g., instrumentation, safety/telemetry systems, and launch facilities) configured to support realistic development and testing of the BMDS. Exhibit 2-15 depicts key components of the BMDS Test Bed. The infrastructure primarily provides GT facilities, range and range instrumentation, and mobile sensors. The existing BMDS Test Bed infrastructure components that support testing as a secondary purpose (e.g., COBRA DANE and the EWR National Energy Technology Laboratory) are described under their respective component (e.g., sensors). A major focus is to develop infrastructure that enables realistic testing by permitting realistic geometries for sensor viewing and interceptor engagements. The Test Bed includes test locations already being used, such as GT sites, or already developed, such as the GMD ETR in the Pacific Ocean. In addition, testing could occur from existing operationally deployed sites in compliance with all applicable Federal, state, and local regulations. The MDA may also develop test beds in other areas such as the Atlantic Ocean, Gulf of Mexico, or outside the continental U.S. to support testing of BMDS components in those areas. In 2012, MDA contemplates the development of a space-based test bed; however, the concept is too speculative to be

analyzed in this PEIS. The BMDS Test Bed provides opportunities to use several target and interceptor missile trajectories that encompass a range of missile threats. Test Bed activities help wargames prove out doctrine; operational concepts; tactics, techniques, and procedures; and concept of operations (CONOPS) in militarily relevant environments.

Exhibit 2-15. BMDS Limited Defensive Capability Block 2004 Test Bed



BMDS Test Bed Components Providing *Limited Defensive Capability are Shown in Red Italicized Font.*

MDA's limited defensive capability (LDC) includes the BMDS components having a limited, combat capability to defeat adversary threats. The LDC allows Combatant Commanders use of the BMDS, to refine operational tactics, techniques, and procedures and exercise command control functions while maintaining a missile defense test and development program. For more discussion of BMDS fielding and deployment see Sections 2.3.3 and 2.3.3.1, respectively.

Test Sensors

The technology and operating environments for test range telemetry sensors, radars, and light detection and ranging (lidar) sensors are the same as the technology and operating environments of the element sensors and the BMDS mission sensors described in Section 2.2.2. During test planning, the MDA would identify the appropriate sensor that would provide the necessary location and functions to support achievement of the test

objectives. BMDS mission sensors and test range telemetry sensors as well as radars and lidars would be returned to their normal non-BMDS mission after each test event. Test sensors would be analyzed for environmental impacts in the same manner as described for weapons and mission sensors. Exhibit 2-16 provides information on representative test sensors that are available for use in BMDS testing. These sensors are further described in Appendix E.

Exhibit 2-16. Summary of Representative Test Sensors

Sensors	Type	Test Telemetry	Operating Environment
Advanced Missile Signature Center	Optical sensors	X	Fixed land-based facility
Air Force Research Laboratory (AFRL) Mobile Atmospheric Pollutant Mapper Carbon Dioxide (CO_2) Lidar	Test Lidar		Mobile land-based
AFRL Ka-Band Radar	Test Radar		Mobile land-based
AFRL Mobile Lidar Trailer	Test Lidar		Mobile land-based
ALTAIR	Test Radar	X	Fixed land-based
AN/FPQ-10 Upgraded	Test Radar	X	Fixed land-based
AN/FPS-16	Test Radar	X	Fixed land-based
AN/MPS-25 AN/MPS-25 (upgraded)	Test Radar	X	Fixed land-based
AN/MPS-36	Test Radar	X	Mobile land-based
AN/MPS-39	Test Radar	X	Mobile land-based
AN-TPQ-18	Test Radar	X	Fixed land-based
ATR-500C	Tracking Radar	X	Fixed land-based
FPQ-14	Test Radar	X	Fixed land-based
High Accuracy Instrumentation Radar (HAIR)	Range Radar	X	Fixed land-based
High Altitude Observatory (HALO)	Infrared/ Optical Sensor	X	Mobile air-based platform
Homing All-the-Way-Killer X-Band Doppler Radar	Test Radar		Fixed land-based
Midcourse Space Experiment (MSX)	Observatory sensors	X	Space-based
Millimeter Wave Radar	Test Radar	X	Fixed land-based
MK-74	Test Radar	X	Mobile land-based

Exhibit 2-16. Summary of Representative Test Sensors

Sensors	Type	Test Telemetry	Operating Environment
Recording Automatic Digital Optical Tracker	Optical sensor	X	Fixed land-based
Tracking and Discrimination Experiment Radar	Test Radar	X	Fixed land-based
W-Band Tornado Radar	Test Radar		Mobile land-based
Widebody Airborne Sensor Platform (WASP)	Tracking Radar	X	Mobile air-based platform

Targets

Because targets are test assets, they would not be deployed in the BMDS in the same way as weapons or sensors. Target missiles would be used to provide realistic threat challenges for testing new and evolving interceptor missile and sensor components that would comprise the BMDS. Target missiles would be used to validate the capabilities of the BMDS missile defense sensors and weapons. Target missiles typically mimic a possible threat, both in physical size and performance characteristics. A wide variety of target missiles would be used to support the development and test requirements of various BMDS elements, and validate their design and operational effectiveness. Targets would be used to test how well the BMDS can track the threat missile, communicate the threat to the appropriate ground command, and employ an interceptor to engage the threat. Targets can be launched from air, ground and sea platforms. The availability of multiple platform options allows the MDA to develop challenging and creative test scenarios, including salvos (i.e., simultaneous discharge of weapons), and also provides numerous viable options for test events to ensure safe testing.

Exhibit 2-17 shows the relative sizes and ranges of some typical test targets. Test targets are sometimes referred to by the names of their stages or motors.

Exhibit 2-17. Typical Test Targets

A typical target missile consists of one or more boosters and a target test object. Boosters are the rocket motors that sequentially activate to launch the missile. Target test objects are the parts of target missiles that are designed to represent threat warheads or reentry vehicles. (The term reentry vehicle is used in conjunction with threat missile.) A target test object typically separates from its booster(s); but some targets are non-separating.

Separating targets can be single-stage, meaning that they have one motor that initiates flight, or multiple-stage, with two or more motors that fire sequentially. Multiple stages allow a target missile to fly at higher velocities and altitudes, and for longer distances. Once the motor on a single-stage target has used all of its propellant, the spent stage may be jettisoned or released from the test object and falls back to Earth, often breaking up into small pieces before it reaches the surface of the designated test area. For targets with multiple stages, the first stage operates similar to a single stage target. However, after the first stage uses all of its propellant, that stage is jettisoned and the second stage or motor is ignited and the target continues on its path. This sequence of events is repeated until all of the stages have been used. Exhibit 2-18 lists the representative targets and boosters used by the MDA. There also are additional targets under development based on the Navy Trident-1 motors and alternative liquid fuel concepts.

Exhibit 2-18. Representative MDA Targets and Boosters

Targets	Aries
	Foreign Material Acquisition
	Hera
	Lance
	Liquid Propellant Target
	Long Range Air Launch Target
	Medium Range Target
	Minuteman II
	PATRIOT as a Target
	Peacekeeper Target Missile
	Short Range Air Launch Target
	Storm
	Strategic Target System
	Strypi
	Trident Target Missile, C-4
	Vandal
Boosters	Antares
	Black Brant
	Castor IVB
	Lynx
	Malemute
	M55, M56, M57
	Orbus
	SR-19
	Talos
	Terrier
	Trident C4 First Stage, Second Stage, Third Stage

The target test object would separate from the booster at a designated point in its flight. Test objects typically consist of steel or aluminum housing assembly, thermal sensors, guidance and control electronics, radio transmitters and receivers, a power supply (which may include lithium or nickel-cadmium batteries), and a Flight Termination System (FTS).

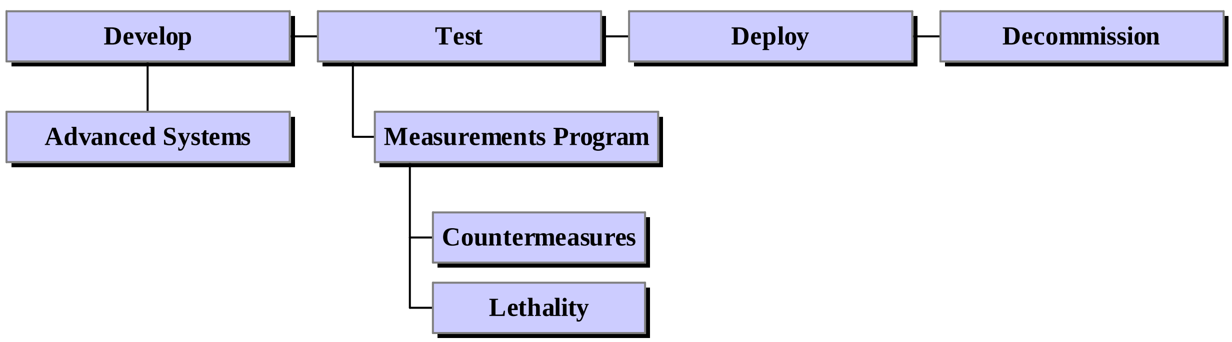
Target test objects may use countermeasures or decoys to imitate threat missiles as well as simulants to imitate the characteristics of the payload of a threat missile. Countermeasures are devices that accompany the target missile during its flight and attempt to confuse the sensors and C2 systems, making a successful intercept more difficult. Simulants are substances that mimic the significant characteristics of chemical, nuclear, biological or explosive payloads carried by threat missiles. Countermeasures

and simulants are also used to support the development and testing of the BMDS. They are programs within MDA's Measurements Program and are discussed further in Section 2.2.5.

2.2.5 MDA's Programs

The MDA implements several programs that support various aspects of the implementation of the BMDS, notably including the Advanced Systems program, the Measurements Program, and the International Program. As shown in Exhibit 2-19, the Advanced Systems program supports the development portion of the BMDS acquisition life cycle. The Measurements Program includes the Countermeasures and Corporate Lethality Programs, which support the test portion of the BMDS acquisition life cycle.

Exhibit 2-19. MDA Programs Supporting the BMDS Acquisition Life Cycle



Given the worldwide implications of ballistic missile defense, MDA also has an active International Program that includes the participation of several international partners in a variety of BMDS-related development and test activities.

2.2.5.1 Advanced Systems

The Advanced Systems program addresses research and technology improvements to enhance, supplement, or replace various building blocks or capabilities as the proposed BMDS evolves over time. Some technology improvements are currently proposed; others will evolve in the future (i.e., cannot be identified at present). Examples of current Advanced Systems projects include Project Hercules, the High Altitude Airship (HAA) and Multiple Kill Vehicles. Additional discussion of the MDA's Advanced Systems program can be found in Appendix F.

2.2.5.2 Measurements Program

To assess and characterize specific aspects of BMDS components' performance during testing, the MDA implements a Measurements Program. The program is designed to provide critical data and analyses that fulfill BMDS requirements identified and

prioritized by the Measurements Program Assessment Team. Measurements tests would be incorporated in individual component tests as well as integrated tests in laboratories, GTs of components, and during flight tests.

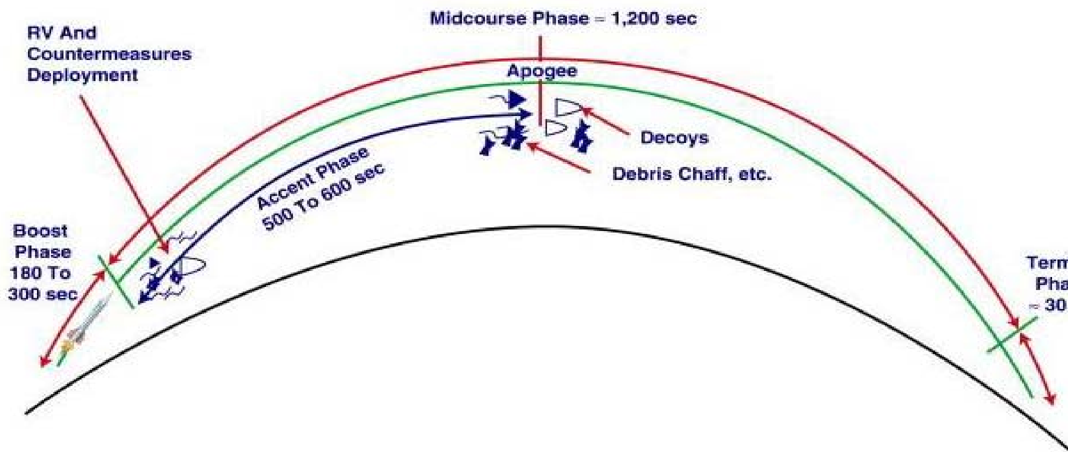
The Measurements Program would conduct critical measurements tests to collect data for all components to support system engineering assessments/performance verifications and ground effects analysis, and to characterize potential or actual countermeasures. At this time, “measurements” includes counter-countermeasures characterization, lethality, kill assessment, discrimination data, phenomenology measurements (the observation, description and explanation of the visible appearance of a test), and other critical measurements. The Measurements Program includes the Critical Measurements and Countermeasures Program (CM/CM), Countermeasure and Counter-countermeasure Program, and the Corporate Lethality Program. The CM/CM program is designed to address discrimination phenomenology, countermeasure performance, BMDS performance degradation, and potential mitigation options. The Countermeasure and Counter-countermeasure program attempts to characterize countermeasure signatures and to assess counter-countermeasure efficacy. Lethality, or the ability of the BMDS to prevent a ballistic missile threat from producing lethal effects, relies on kill assessment and other data gathered by BMDS component sensors and test sensors. Data are gathered through the Optical Data Analysis, Radar Data Analysis, and Radar Data Exploitation Programs.

Countermeasures

Countermeasures are designed to increase the probability that the reentry vehicle from a threat missile reaches its intended target. BMDS testing would include the use of robust countermeasures designed to mimic those that could be used on potential threat missiles. By testing the capabilities of U.S. interceptors against realistic targets including countermeasures the ability of the U.S. to respond to an enemy missile attack would be greatly enhanced. The specific signature and nature of the countermeasures that would be used as part of the BMDS testing activities are classified. Therefore, the discussion in this document on the potential impacts of countermeasures that would be used in BMDS testing is generic in nature.

There are two primary types of countermeasures, penetration aids or penaids and inherent countermeasures. Penaids are items that are added to the missile to increase the chance of the missile reaching its intended target. Penaids could be housed in the target reentry vehicle separation module. One penaid technique is for an offensive missile to carry, in addition to the actual target reentry vehicle, several decoy target reentry vehicles. These decoys, shown in Exhibit 2-20, when released, appear to be actual warheads. Inherent countermeasures are elements of normal operations of missiles that make it harder for interceptors to identify and destroy the target missile. This would include the separation

Exhibit 2-20. Deployment of Countermeasures during Flight Phases



of the reentry vehicle from the booster, which decreases the size of the portion of the missile to be tracked and destroyed by the interceptor.

There are various basic categories of countermeasures that could be used by MDA in characterization and in testing the BMDS. These include simulation, anti-simulation, traffic maskers/obscurants, aim point denial, and maneuver. Each uses different methods to add potential threat characteristics to targets used in the Measurements Program or in other BMDS testing.

Simulation countermeasures deploy various materials to confuse sensors and prevent them from correctly identifying the reentry vehicle. These countermeasures would primarily be fabricated from graphite, stainless steel, and tungsten. Anti-simulation countermeasures attempt to disguise the reentry vehicle by making the reentry vehicle look to the sensors like something other than a reentry vehicle. Traffic countermeasures deploy many items at once; this could include using multiple reentry vehicles or multiple countermeasures to confuse sensors. Maskers or obscurants are materials or objects that move in flight along with the reentry vehicle to confuse the sensors and prevent them from correctly identifying the reentry vehicle. Aim point denial is the ability to confuse the sensors from identifying the point on the reentry vehicle that should be hit to prevent the reentry vehicle from reaching its intended target. Maneuver countermeasures include the ability of reentry vehicles to change trajectory as they enter the atmosphere thus preventing the interceptor from predicting the path of the reentry vehicle. Other countermeasures are designed to increase the probability that the reentry vehicle reaches its intended target.

Lethality

Lethality is a measure of the ability of the BMDS to prevent a threat ballistic missile from producing lethal effects. Preventing a threat missile from completing its mission could entail the use of kinetic energy (hit-to-kill and blast fragmenting weapons) or directed energy (laser) to intercept and neutralize the target. Adequate lethality of the interceptor missile ensures the destruction of incoming enemy warheads to minimize potential threats. Lethality effects are described as either hard kills or soft kills. A hard kill occurs when damage done directly to the threat at the point of intercept results in the payload's immediate destruction. A soft kill occurs when damage done to the threat either causes the threat's destruction due to the effects of atmospheric drag/reentry on surviving payloads or prevents the payload from reaching its intended target. Lethality analyses begin at the moment of impact and continue through to interaction of the target pieces and any surviving payload contents with the Earth. The MDA is developing criteria to evaluate the lethality capability of BMDS technology against various threats. Potential enemy threats could include bulk High Explosive, High Explosive-laden submunitions, nuclear, biological, chemical, and bulk chemical payloads carried on tactical ballistic missiles.

Lethality studies include the monitoring and analysis of threat payload destruction and dispersion during intercepts of test threat targets. Although limited testing is done on actual lethal agents under controlled laboratory conditions, most of the testing relies on a number of payload simulants that, while chemically and biologically neutral, mimic the significant qualities, such as dispersion, weight, and viscosity of a toxic or hazardous substance for test purposes. Testing would require the use of existing simulants and may require the use of newly developed ones.

Because the countermeasures and lethality programs support BMDS testing, they will be considered along with other test assets (i.e., test bed, test sensors, and targets) in the analysis of impacts in Section 4.

2.2.5.3 International Programs

The MDA's mission is to develop and field an integrated BMDS capable of providing a layered defense for the U.S. homeland, deployed forces, allies and friends against ballistic missiles of all ranges in all phases of flight. To this end, the MDA supports a variety of international programs and invites international participation in its own programs. For example, the Arrow System Improvement Program is a joint undertaking with Israel, which will include technical cooperation to improve the performance of the AWS and a cooperative test and evaluation program to validate the improved performance.

2.3 BMDS Life Cycle Activities

This section describes the activities that occur during each phase of the acquisition life cycle (i.e., development, testing, deployment, and decommissioning) for BMDS components.

2.3.1 Development of BMDS Components

The MDA would develop the necessary components of the BMDS using an evolutionary spiral development process described in Section 2.1.3.2. The MDA would use existing infrastructure and components, when feasible, and would add emerging and new technologies as they become available. The components would be combined into specific configurations to achieve desired functional capabilities. Development activities would contribute to the evolution of the BMDS design as existing component configurations are altered or new configurations are created in response to evolving functional capabilities. During the development of new and modified components, environmental and occupational safety and health procedures would be developed. As outlined in Exhibit 1-3, development of BMDS components includes activities such as planning, budgeting, research and development, systems engineering, site preparation and construction, maintenance and sustainment, manufacture and initial testing of prototype test articles, and conduct of tabletop exercises.

2.3.1.1 Weapons

Weapons include interceptors and lasers as described in Section 2.2.1. Development of weapons components would build on existing infrastructure and capabilities of the BMDS elements. Research and development activities for weapons that could potentially have environmental consequences include research and development activities such as developing and testing propellant formulations for new rocket motors, developing or selecting casing materials, and developing and testing subscale rocket motors. System engineering tests such as hardware-in-the-loop tests would involve using an actual kill vehicle, intercept sensor unit, or directed energy component electrically connected to a computer system that simulates the functions of the other components of an interceptor. Repair, maintenance, and sustainment of weapons systems would include checks to ensure that system technology is still viable and cleaning, which may involve the use of solvents. Manufacturing and initial testing of prototype weapons technology may require static-fire testing of boosters or the firing of the HEL and may also involve the use of a sled (i.e., a carrier vehicle that is designed to move along a section of rail at speeds approaching missile flight velocities) to test boosters or to provide target opportunities. Tabletop exercises would allow developers to plan the interaction of a weapons system's internal technology, as well as its interaction with other components. These activities would occur at both contractor and government facilities and would include environmental and operational tests under simulated field conditions and computer simulations.

2.3.1.2 Sensors

The development of sensors would build on existing sensors and infrastructure including the current development efforts for radars such as X-band, S-band, L-band, C-band, and infrared, optical, and laser sensors as described in Section 2.2.2 and Appendix E. The types of activities involved in developing sensor components would include planning, budgeting, research and development, systems engineering, repair, maintenance, and sustainment, manufacture and initial testing of prototype test articles, and conduct of tabletop exercises. Research and development of mobile systems might include transportability demonstrations, possibly using aircraft and ground transport. All other development activities for sensors would be similar to those required for weapons. For example, systems engineering tests would include environmental and operational tests under simulated field conditions and computer simulations. These activities would occur at both contractor and government facilities and would include environmental and operational tests under simulated field conditions and computer simulations.

2.3.1.3 C2BMC

C2BMC includes the hardware and software and related infrastructure that connects and integrates the BMDS as described in Section 2.2.3. Development occurs in close conjunction with the weapons and sensors components described above and would utilize the existing assets and infrastructure when feasible. Development activities would include planning, budgeting, research and development, systems engineering, repair, maintenance, and sustainment, manufacture and initial testing of prototype test articles, and tabletop exercises.

For purposes of this PEIS, analysis of the environmental impacts associated with the installation, construction, or manufacture of C2BMC equipment and facilities will be considered, including computer terminals and displays (hardware) and the necessary computer programs (software) to provide BM and C2 functionality. C2BMC improvements may include simple software upgrades, updated computers, new facilities, buried communications cable, and, possibly, construction of new centers. Additionally, the analysis includes communications assets such as military and commercial satellite communications (COMSATCOM) terminals and antennas, radio communications terminals and antennas, and above- and below-ground communications cables (e.g., fiber optic and copper). A satellite communication system would provide satellite communications among C2BMC nodes. The satellite system would consist of satellite terminals, equipment buildings housing communications enclosures, backup power and dish antennae. The In-Flight Interceptor Communication System Data Terminal (IDT) is a part of the C2BMC and provides an in-flight communications link between nodes and interceptors. If a new satellite system or IDT system would be required, impacts would result from building construction and launch of the satellites. Fiber optic cable uses light pulses to transmit information along fiber optic lines. Where new fiber optic cable is

required, cable may be installed on either side of existing rights-of-way (e.g., normal roads or railroad tracks). Typically, fiber optic cable would be buried to a depth of approximately one meter (three feet) from the surface.

2.3.1.4 Support Assets

Support assets as described in Section 2.2.4 are the mobile and fixed auxiliary equipment, vehicles, and facilities that are needed to support and facilitate the operation and on-going evolution of BMDS components and testing of the system. Development of support assets including test assets for the BMDS would be closely coordinated with the development of the weapons, sensors, and C2BMC components. Planning for future support assets is critical to ensuring that they are acquired in time to meet the needs of upcoming BMDS components.

BMDS Test Bed

The BMDS Test Bed would encompass the infrastructure and environment where testing takes place. Development of the Test Bed would focus on planning for and acquiring infrastructure that enables realistic testing by permitting realistic geometries for sensor viewing and interceptor engagements. The proposed Test Bed includes test locations already being used, such as GT sites, or already developed, such as the GMD ETR in the Pacific Ocean. The MDA may also expand the Test Bed to include other areas in the Atlantic Ocean, Gulf of Mexico, outside the continental U.S., and ultimately a space-based test bed to support robust and realistic testing of BMDS components in those areas. The MDA would use existing sensors and launch facilities along the Atlantic and Gulf coasts to evaluate phenomenology and interoperability of sensors. Exhibit 2-21 lists the facilities in the Atlantic or Gulf of Mexico that are currently used for MDA activities or may be used in the future and could be eventually included in the BMDS Test Bed. Some facilities are independent, and others fall under the jurisdiction of a Range. Those installations that are under the jurisdiction of a Range are presented beneath that Range. The MDA would use launches from NASA and U.S. Air Force (USAF) facilities as targets of opportunity to reduce the number of MDA launches required.

Exhibit 2-21. Facilities Available in the Atlantic or Gulf of Mexico

Facility	Location
Gulf Test Range/Eglin AFB	Florida
Cape San Blas	Florida
Santa Rosa Island	Florida
Mobile Sea-Based Platform	Broad Ocean Area (BOA)
Eastern Test Range/Cape Canaveral Air Force Station	Florida
Mobile Sea-Based Platform	BOA
NASA Kennedy Space Center	Florida
Tyndall AFB	Florida
Space Port Florida (Florida Space Authority)	Florida
ISTEF – Merritt Island	Florida
Mobile Sea-Based Platform	
Cape Cod Air Station	Massachusetts
Hanscom AFB	Massachusetts
Lincoln Space Surveillance Complex	Massachusetts
Redstone Arsenal	Alabama
Naval Air Test Center Patuxent River	Maryland
Aberdeen Proving Ground	Maryland
Ocean City Municipal Airport	Maryland
NASA Wallops Flight Facility	Virginia
Newport News Municipal Airport	Virginia
GBI Development and Integration Laboratory	Alabama
Stennis Space Center	Mississippi

Test Sensors

Development of test sensors, as described in Section 2.3.1.2, would include activities similar to those that would occur in the development of the BMDS mission sensors and BMDS element sensors.

Targets

Preparing targets for flight test events would involve designing, prototyping, developing, procuring, certifying and qualifying them. Targets would be developed in response to the needs of BMDS and element testing requirements. To reduce costs, several targets would use retired components from other programs, including the U.S. Army Pershing II program, U.S. Navy Polaris program, Trident-1 (C-4), and U.S. Air Force Minuteman II program, as well as some Foreign Material Acquisitions. This practice would not only reduce the amount of raw material used but would also limit the amount of production

needed to develop realistic threat targets. These retired components may be used in their original configuration, or may undergo minor reconfiguration, depending on the specifications of the test. Every target system currently built meets unique test requirements; therefore, production of target systems is item-by-item and not in quantities. MDA is developing a family of targets to provide a standard target missile to support short-, medium-, and long-range test requirements.

Advanced target applications in progress include short- and long-range air-launched targets and liquid fuel boosters, as well as a multi-mode medium-range target. MDA is developing a family of targets that provides standard target missiles to support short, medium and long range test requirements. Mobile launch/basing platforms are being considered, along with the development and future procurement of advanced countermeasures and payloads.

Countermeasures

Development of countermeasures would involve detailed planning for test events, and identifying test objectives, appropriate countermeasures and counter-countermeasures, and acquiring any necessary materials.

Two types of defensive measures would be used to oppose countermeasures. The first would be improving sensor technology to more completely discriminate between the reentry vehicle and any deployed countermeasures. During the development of flight tests involving countermeasures, appropriate sensors would be selected and scheduled to participate in the test event. The second defensive measure would be improving interceptor technology to increase the chance that the interceptor can correctly identify and destroy the reentry vehicle. Development activities would include modeling and simulation as well as ground testing to characterize physical properties of countermeasures and predict behavior during flight tests.

Lethality

Assessing lethality involves the use of chemical or biological simulants that, while chemically and biologically neutral, mimic the significant qualities of a toxic or hazardous substance for test purposes. Development of simulants would involve research and planning, identification of neutral or inert substances with the required physical properties for specific tests, and in some cases manufacturing significant quantities of the simulant.

2.3.2 Testing of the BMDS

Testing is a critical aspect of the BMDS life cycle and under the spiral development process would occur simultaneously with the development and deployment periods of the life cycle acquisition process. Testing allows for the life cycle of all BMDS components to be closely correlated so that efforts in particular areas of the BMDS may be truncated or canceled if the results are unsatisfactory or where the development effort should be shifted to another integrated BMDS element to permit acceleration.

Testing will require several basic activities as outlined by component in Exhibit 1-3. Weapons, sensors and C2BMC components would be manufactured specifically for a test event, and appropriate site preparation and construction would be conducted at the test location. Infrastructure in the Test Bed would be constructed and prepared and components transported to the site, as necessary, and interceptors and targets would be assembled and fueled. Where necessary, sensors would be assembled before activation. The appropriate occupational safety and health procedures and appropriate training would be developed and followed for these activities.

Testing occurs at the component (Section 2.3.2.1), element (Section 2.3.2.2), and system (Section 2.3.2.3) levels. The goal of BMDS testing is to demonstrate integrated and effective functioning during increasingly complex and realistic engagement sequences. An engagement sequence is a unique combination of detect-control-engage functions performed by BMDS components (such as sensors, weapons and C2BMC) used to engage a threat ballistic missile. The C2, BM, and fire control functions enable the engagement sequence. Individual component and element tests are required to demonstrate the functionality of BMDS technology. Element tests evaluate the ability of component configurations to work together. These tests are the beginning of integrated BMDS tests. Some components may not be designed to be a part of an element (e.g., upgraded EWR). In those cases, the component would move from component level testing directly into System Integration Tests. See Section 2.3.2.3 for description and discussion of System Integration Tests. Integration testing is the activity that occurs above and beyond that which is required during the demonstration phase for each component or element. Integration system testing assesses the ability of BMDS components to work as a unit and to meet the required functional capabilities of the system.

2.3.2.1 Component Tests

The following describe the test activities that would be performed for each of the components in the proposed BMDS.

- **Weapons.** Weapons testing activities for interceptors would include the static firing of rocket boosters, sled tests, and isolated flight tests to confirm booster function (for single and multiple stages). For lasers, testing would demonstrate laser function and individual operation of laser-related components**.**

- **Sensors.** The primary objective of sensor component testing would be to evaluate performance in detecting and tracking surrogate threat ballistic missiles. Tests would utilize targets of opportunity, that is, launches supporting other research programs. Performance would be evaluated by comparing observed and predicted performance on target detectability, measurement accuracy, and tracking accuracy. In general, test objects representative of the reentry vehicles and countermeasures would be required to support both development and operational test and evaluation activities.

- **C2BMC.** The C2BMC must receive, fuse, and display tracking and status data from multiple components and coordinate firing/launches and intercepts. Testing would involve modeling and simulations to assess hardware and software capabilities and to demonstrate interoperability prior to participation in test events. C2BMC components would be tested in concert with their corresponding weapons and sensors components.

- **Support Assets.** Testing of support assets (including test assets) is discussed separately following the discussion of System Integration Tests. This includes the discussion of MDA Measurements Program countermeasures and simulants testing as part of test assets.

Testing of individual components has been largely addressed in existing NEPA analyses as listed in Appendix C, Related Documentation.

2.3.2.2 Element Tests

Element tests are required to evaluate the ability of component configurations to work together. Descriptions of element test activities and status by block are described in Appendix D, Descriptions of Proposed BMDS Elements. Testing of individual elements and support asset components have been largely addressed in existing NEPA analyses as described in Appendix C, Related Documentation.

2.3.2.3 System Integration Tests

The MDA is proposing to perform integration test activities on existing and planned components such as sensors, weapons, and C2BMC equipment. Integration testing of BMDS components provides system characterization, verification and assessment. Integration testing assesses the ability of BMDS components to work as a unit and to meet the required functional capabilities. Ongoing demonstration activities are required to assess a component’s continuing utility within the system. System Integration Tests

would be used to demonstrate BMDS performance. System Integration Tests rely on a foundation of individual component tests and culminate in SIFTs. This section describes typical flight test activities, the approach and descriptions of integration test events, and the contribution of the MDA's BMDS Measurements Programs to the assessment of technological capabilities.

Typical Flight Test

A typical weapons flight test would involve the use of a simulated airborne target, the use of a drone, or the launch of a target missile, the launch of an interceptor missile or the firing of a laser, and the intercept of the simulated threat missile target. Flight-testing also would provide measurements on the effectiveness against countermeasures and the lethality of the kill vehicle.

The MDA would deploy personnel and assets to the test locations to prepare for the flight mission (FM), conduct the flight test, and refurbish the test sites to pretest conditions, if applicable. Prior to a test event, the target launch site(s) would generally be occupied for approximately three months before a scheduled launch and about two weeks after a launch. A typical three-month launch cycle ramp-up would include 25 people during the first month, 25 to 75 people during the second month, and 100 to 150 people during the third month. Dual target launches would include approximately 25 people during the first month, 75 to 100 people during the second month, and 150 to 175 people during the third month. After a launch, approximately 50 personnel would immediately depart, and the remaining personnel would depart after launch site refurbishment.

The MDA would launch target missiles in a manner that represents relevant adversarial capability and provides the components with opportunities to practice their function in a realistic situation. The duration of a typical test flight would vary based on the component(s) that are involved and the flight phase where intercepts would occur. Flights with a planned intercept in the boost phase would last up to five minutes. Flights with intercepts in the midcourse phase would last from about five to 20 minutes. Flights with intercepts in the terminal phase would last up to approximately 20 to 30 minutes. Airspace surveillance procedures, which would be implemented to ensure range safety, would last as little as 45 minutes or longer if the test is delayed.

After launch, the target missile would slowly gain speed in the first few seconds of flight, and then rapidly accelerate out of sight and earshot. One minute into flight, a typical target missile would be at an altitude of approximately 16 to 19 kilometers (10 to 12 miles). The first stage would burn out, and in the case of a separating target, would fall within the predicted booster impact area. The second and third stages (if used) would perform in similar manners, and the target missile would climb out of the atmosphere and into space. The reentry vehicle or non-separating target would reenter the atmosphere and decelerate until it is intercepted or until the mission is completed.

To intercept the target missile, the tracking radar would acquire and track the target while the interceptor C2 system computes the best time to launch the interceptor missile. The interceptor missile would then be launched. Approximately one minute into flight, the interceptor would be at an altitude of about 50 kilometers (31 miles) and approximately 65 to 80 kilometers (40 to 50 miles) down range. (The altitude and distance down range will depend greatly on the trajectory and type of missile.) The first stage would burn out and fall within the predicted booster impact area. The second and third stages (if used) would ignite, and the interceptor would continue along its intended path. After burnout, the second and third stages would fall into their designated impact areas. After the final stage burnout, the interceptor, or deployed kill vehicle, would continue its flight until the target is intercepted. If the intercept were unsuccessful, the interceptor or kill vehicle would be destroyed by mission control or would be allowed to return to Earth. All booster stages and interceptors would be programmed to land in predetermined and verified clear areas. Intercept altitudes could vary from approximately 100 to more than 250 kilometers (62 to more than 150 miles). (The altitude and distance down range would depend greatly on the trajectory and type of missile.)

System Integration Testing Approach

The BMDS Test Program provides for a cohesive testing program of the interoperability of all Block architecture components and elements. System Integration Tests would involve interaction between and assessment of ground-, sea-, air- and, in some cases, space-based test assets. As the BMDS evolves, System Integration Test scenarios would become more complex and realistic to evaluate the integration of a higher number of working elements and components. More realistic scenarios would introduce an increasing number of targets. In addition, critical measurements programs may start as early as the components level and go up through integration system tests.

MDA’s Responsible Test Organization provides the single point of responsibility, authority, and accountability for the BMD System Integration Testing. The Responsible Test Organization manages the test bed infrastructure and collaborates with the elements and components to develop system characterization and coordinate System Integration Tests. The Combined Test Force (CTF) is the execution arm of the Responsible Test Organization that develops long range and detailed plans, provisions, executes, acquires data from and analyzes the Campaigns.

The System Integration Test planning process is driven by goals that are laid out in guidance and technical objective documents. These objectives indicate the functional capabilities that need to be met by BMDS technologies. From the overview documents, a series of more detailed planning documents outline the details of test objectives, test requirements, and scenarios for System Integration Testing. These documents would be developed and revised regularly. Combinations of components that can meet functional capabilities would be identified. Dedicated component and element tests would be

synchronized to create a System Integration Test. Supporting components are identified to maximize the amount of data that can be gathered during a System Integration Test. System Integration Tests include modeling, simulation, and analysis, missile defense wargames, missile defense integration exercises (MDIEs), integrated GTs, and one or more SIFTs. System Integration Tests may also be performed for targets of opportunity. SIFTs are the culminating test event combining all prior test activities. These testing events evaluate component and integrated system performance and readiness.

A brief description of each type of System Integration Tests is provided in Exhibit 2-22.

Exhibit 2-22. Description of System Integration Tests

Test	Description
Modeling, Simulation, and Analysis	Modeling, simulation, and analysis are used during test planning, rehearsal, prediction of test outcomes, and post-flight assessment to verify and update models.
Integrated Missile Defense Wargames	Integrated missile defense wargames are table-top or computer simulations of military operations involving two or more opposing forces, using rules, data, and procedures designed to depict an actual or assumed real-life situation.
MDIEs	MDIEs are designed to characterize interoperability and how BMDS software components communicate prior to actual test flights.
Integrated GTs	GTs are tests used to collect data for BMDS components characterization and assessment and do not include booster function flight tests. GTs aim to reproduce the existing state of BMDS architecture, typically components scheduled for upcoming flight tests, to prepare for those flight tests and to assess component performance. For the purposes of this PEIS GTs do not include activities associated with components but rather have been focused on System Integration Testing.
SIFTs	SIFTs are conducted to verify the integration of select BMDS components. These tests generally include a target launch, sensors tracking the target, laser activation or an interceptor launch, and sensors to determine whether the target was destroyed. The number of sensors, weapons, and targets used in a SIFT can be adjusted to create the desired test scenario.

Modeling, Simulation, and Analysis

Modeling, simulation, and analysis are used to provide insight on test design and potential range constraints. Models are used prior to tests to rehearse and predict the test outcomes. In the post-flight phase, models are used to assess and analyze test results. Use of models allows the actual tests to be more successful, for example, by ensuring that a test does not violate a range constraint. Modeling also allows for "overlaying," a technique to predict and evaluate a component's response to a test exercise in which it did not participate. Analysis of post-flight data also allows the validation, verification and update of models.

Integrated Missile Defense Wargames

Integrated missile defense wargames are simulations, by whatever means, of military operations involving two or more opposing forces, using rules, data, and procedures designed to depict an actual or assumed real-life situation. They are designed to gain insight into how human decision-making affects the use of BMDS components. The MDA would use wargames to confirm the effectiveness of its CONOPS. The MDA could conduct multiple system-wide wargames per year. Prior to a wargame event, the MDA would determine the necessary data requirements. Integrated missile defense wargames are tabletop and computer simulation based and do not have a field component. Actual participants attend each wargame and the results allow insight into the information exchange between the BMDS elements and components, coordination during engagement, inventory expenditures, and improvement to CONOPS. For example, prior to a Campaign, an integrated missile defense wargame would be conducted with players and observers to examine BM schemes, shot doctrines, and other operations procedures.

Missile Defense Integration Exercises (MDIEs)

MDIEs are exercises designed to characterize how BMDS software components are communicating. The MDA has developed a Missile Defense System Exerciser to support interoperability testing. Its primary purpose is to characterize the interoperability among the BMDS elements, ensuring the ability to operate as a single system. Throughout the development of the BMDS, there are frequent updates to software, particularly the C2BMC software. The Missile Defense System Exerciser allows for tests of MDA software and hardware. An MDIE would be conducted specifically to support block software integration prior to SIFTs. The MDA plans to conduct multiple MDIEs per year.

Integrated GTs

GTs are tests used to collect data for BMDS characterization and assessment, and do not include component testing activities and System Integration Tests. For purposes of this PEIS, static test firings of rocket boosters, sled tests, or booster function flight tests are considered component level GTs. Component tests have largely been addressed in existing NEPA analyses as identified in Appendix D. Those analyses that were incorporated by reference are included in Appendix C. The analysis of GT activities considered in this PEIS focuses on system integration GTs, which would provide an understanding of the BMDS component integration and assessment, as well as how each component responds in different situations. Such tests provide data on risk reduction for system flight tests and for scenario exploration where flight-testing is either impractical or impossible. System integration GTs aim to reproduce the current state of BMDS architecture, typically components scheduled for upcoming flight tests, to prepare for those flight tests and to assess component performance. The GT tool must include weapon and sensor representations to do system performance testing and must be connected to a test bed as well as other deployed systems.

System Integration Flight Tests (SIFTs)

SIFTs measure BMDS component interoperability and assessment of BMDS functional capabilities in each developmental Block. SIFTs are the culminating test event that relies on testing activities such as integrated missile defense wargames and MDIE test events discussed above. They involve interaction between and assessment of ground-, sea-, air-, and, in some cases, space-based components. Each of the SIFTs incorporates dedicated component and element tests scheduled to occur at the same time. For example, testing of a specific interceptor would be synchronized to occur with the dedicated test of separate radar. The MDA plans to conduct up to two SIFTs per year.

Additional test components could be included in a SIFT to support data collection and overlays. For example, during a dedicated test of GMD's ability to track and intercept a threat missile, the Aegis SPY-1 radar could be used as a forward sensor to track threat missile trajectory and relay it to the GMD interceptor. Any number of extra sensors could be tested during the SIFT to confirm other sensors' tracking data. Overlaying is a technique to predict and evaluate a component's response to a test exercise in which it did not participate. For example, the response of a PAC-3 interceptor to a threat that a THAAD interceptor actually engaged can be modeled to generate additional data and predictions.

Planned System Integration Tests

The MDA has planned a series of System Integration Tests to evaluate the status of the BMDS and its components. Activities conducted during a System Integration Test

include the planning of integration tests, production of components and support and test assets, and implementation of actual flight tests.

Targets and Countermeasures activities for Block 2004 would include the development of full-up target systems to support BMDS and element testing; development of payload suites for CM/CM flight tests and target risk reduction flights; and the maintenance, surveillance, refurbishment and routine testing of existing Government Furnished Equipment boosters.

The MDA plans to conduct a series of additional System Integration Tests to test the BMDS capabilities in Block 2004 and beyond. System Integration Tests represent independent flight tests that leverage from existing element or component tests. Future block testing would be planned and developed to meet the needs of the BMDS at the time of testing. Therefore, details of these integrated test events are only conceptual at this time. The general objectives and investment priorities for future Blocks include testing and validation efforts with a focus on integrated flight tests, with added realism and more stressing threat countermeasures. The BMDS layered defense is envisioned to be developing a strong boost phase intercept capability.

This PEIS examines the range of System Integration Test events as planned and described above. However, of the System Integration Test events, the GTs and SIFTs represent the most realistic testing scenarios. GTs involve the simultaneous activation of multiple sensors and C2BMC components, which would coordinate the control and transfer of information between weapons. A SIFT combines a range of test activities into a single test event that may occur over several days. SIFTs are designed to be increasingly complex integration tests over time. GTs and SIFTs are the only System Integration Tests with a field component and thus have the broadest range of potential environmental consequences. The example SIFT scenario described below is designed to capture the range of environmental effects that could occur from increasingly complex integrated testing of the BMDS. This example is meant to show a representative SIFT that could be conducted as part of the Proposed Action; it is not meant to be inclusive or exclusive of testing possibilities or launch trajectories.

Generic SIFT

A generic example of a SIFT would comprise initial selection of a launch and intercept of a single threat missile. In general, targets and interceptors would be launched from sites in the Test Bed. As a threat missile was launched, specific sensors would be tasked with acquiring and tracking the boosting threat missile and passing cueing information through the C2BMC to other sensor and weapon components. As the threat missile enters its midcourse phase, tracking responsibilities might be transferred to another component designed for that phase of flight. Additional cueing information would be passed again through the C2BMC to interceptor components. The threat reentry vehicle would be

identified and an interceptor launched. Intercepts would occur over designated land areas and BOAs. Once the threat had been intercepted, the component would perform a hit assessment and notify C2BMC of the results.

For example, a representative SIFT could include the GMD element engaging an ICBM long range target in the boost phase, with Aegis BMD acquiring and tracking the target from another location and sending the data to GMD. At the same time, Aegis BMD could engage a different target in the midcourse phase, with ABL acquiring and tracking the target during the boost phase. THAAD could engage another target in the terminal phase, coordinating with PAC-3 to identify the reentry vehicle. Additional components and elements could participate, by using the event as a target of opportunity (TOO) to validate their system performance.

Using information gathered during the SIFT; overlay scenarios would be constructed for other interceptor components. These scenarios would provide the ability to assess the capacities and limitations of each component in intercepting the threat without additional flight tests. Simulation overlays would also serve as a risk reduction in the integration of the components into the BMDS.

Future System Integration Tests

As discussed previously, System Integration Tests are designed to measure BMDS component interoperability and to assess BMDS functional capabilities. As the BMDS evolves to meet emerging threats, System Integration Tests must reflect the increasing number of integrated components. System Integration Tests become more complex as those components occupy more geographically diverse locations. Modeling, simulation, and analysis; MDIE; and integrated missile defense wargames are virtual tests (modeling and computational analyses) or software compatibility and communication tests that would be conducted within existing laboratory or test facilities. GTs involve the simultaneous activation of multiple sensors and C2BMC components, which would coordinate the control and transfer of information between weapons. However, SIFTs could involve the launch of targets and firing or launch of interceptors in addition to the participation of multiple sensors and C2BMC components.

SIFT scenarios attempt to capture more realistic intercept parameters. For purposes of this analysis, two representative scenarios that could be used during SIFTs under Alternatives 1 and 2 were considered. These two scenarios involve similar activities (launches of targets, use of multiple sensors, and use of land-, sea-, air-, and for Alternative 2 space-based weapons); however, they differ in number of target launches and number of weapons used. Both SIFT scenarios may be used to support the proposed BMDS and are analyzed in this PEIS.

SIFT Scenario 1 represents the simplest SIFT and would include the launch of a single target and use of a single weapon component to intercept the target. This scenario would use multiple sensors and C2BMC components. Under SIFT Scenario 1, the launch of the target and the activation of a laser or launch of an interceptor may occur within the same biome or may involve multiple biomes. As BMDS capabilities are proven, a second SIFT Scenario (*SIFT Scenario 2*) is envisioned that would build upon SIFT Scenario 1.

SIFT Scenario 2 would include the launch of up to two targets. For each target launch, more than one weapon component would be able to engage or "take a shot" at the target. Dual-target or interceptor launches would occur within seconds or minutes of each other. As with SIFT Scenario 1, numerous sensor components also would acquire the target and relay tracking data. Under this test scenario, the two targets may be launched from one biome and the weapons may be activated or launched from the same or different biomes.

SIFT scenarios are confined by geographic as well as range constraints that limit the number or types of launches that can occur at a specific location based on infrastructure and allowable debris impact zones. Each facility has either physical limits or regulatory limits on the number of simultaneous launches that it can execute. Test objectives also would limit the types of targets, countermeasures and simulants used.

The MDA would conduct future SIFTs in the existing or an expanded Test Bed. The current Test Bed is based around the Pacific Ocean. However, additional test facilities along the Atlantic Ocean and Gulf of Mexico as well as components located outside the continental U.S. may also be used.

2.3.2.4 Role of Test Assets in Integrated Testing

The MDA would use test assets to enhance the BMDS by simulating a threat missile in a realistic environment. Specific target missiles would be configured to meet the objectives of a SIFT scenario. Test assets would also support integration testing by providing infrastructure needed to assess the performance of components and systems, e.g., non-BMDS test sensors and telemetry may be used to acquire, record, and process data on targets and interceptors during testing.

Test Bed

The BMDS Test Bed would provide opportunities to use several target and interceptor missile trajectories that encompass a range of missile threats. Test Bed activities would help wargames prove out doctrine; operational concepts; tactics, techniques, procedures; and CONOPS in militarily relevant environments. Components of the Test Bed provide

IDC.[30] The IDC is comprised of the technical capabilities (hardware and software) of the BMDS available for operations on September 30, 2004. After the Combatant Commander has completed the requisite planning and the operators have been trained, qualified and certified to effectively employ the IDC equipment, along with the supporting integrated logistics and training systems, the components will constitute IDO.

Test Sensors

The primary objective of test sensor testing is to evaluate performance in detecting and tracking surrogate threat ballistic missiles. Tests would use targets of opportunity (TOO) as well as BMDS targets. Performance would be evaluated by comparing observed and predicted performance of the test sensor's ability to detect the target, accurately measure and track the target, and discriminate the reentry vehicle from countermeasures. In general, test objects representative of the threat ballistic missiles, reentry vehicles, and countermeasures would be required to support both development and operational test and evaluation activities for test sensors.

Targets

Target missiles are tested individually in risk reduction flights, to demonstrate their flight capabilities and ensure their safe operation. They are also used to test the capability of sensors. In interceptor tests, targets are used to test the coordination of the sensors, interceptors and C2BMC in completing a successful intercept. In some instances, the objective of the test event is to track and destroy the target with the defensive interceptor. Targets are also involved in flight tests as TOO. Tests using TOO rely on launches supporting other programs. In this instance, another program would participate in a passive role in a flight test, perhaps testing the ability of its sensors to track the target and communicate its properties to the appropriate ground control.

Flight-testing would be performed to verify performance and to test the interceptor's ability to engage and destroy target missiles under realistic conditions. Certain tests would involve only the acquisition of the target missile by the interceptor's seeker/sensor, while in other tests the target missile would be destroyed. In all cases, safety analyses would be conducted to ensure human health and safety are maintained and to avoid or minimize the possibility that any debris would cause harm to environmentally sensitive resources. Typically, several flight tests are conducted within a given test program.

Targets are transferred to their test locations by air, barge, and/or over-the-road truck for system assembly and checkout. Some missile components may be shipped to an airfield near the launch site and transferred to the launch site by local truck. Once target missiles

[30] IDC refers to the sensors, C2BMC, and weapons from Block 04 that are available for limited, militarily useful capability by September 2004. The IDC will include early warning and tracking sensors based on land, at sea, and in space, C2, and GBIs for midcourse and terminal intercepts.

reach the test range and are assembled, an appropriate Explosive Safety Quantity Distance (ESQD) would be established and maintained around facilities where ordnance would be stored or handled. Target missile launch preparation at ground launch sites may include the following activities: construction and/or modification of facilities and infrastructure to support launch preparation and flight test activities; fueling of liquid targets; transportation, handling, and storage of target missile system components and assemblies; assembly and maintenance of target missile and support equipment; and checkout and testing of target missile system components and assemblies.

Activities associated with ground, air, and sea launched targets differ based on the launch platform. In general, target missile operations at the test site may include missile assembly and checkout, maintenance, final inspections, testing and checkout for the reentry vehicle, and placement of the target on the launch pad.

Ground Launch Targets

Land launches of target missiles would be accomplished from a launch pad, launch stool, silo, or runway. Missiles would be assembled and checked out and erected on the launch stool or the pad or transferred to a launch silo before a scheduled test launch. Unmanned aerial vehicles or drones could also be used as targets. Drones can use a variety of engines including turbojet engines and gasoline powered combustion engines. Each missile storage or processing facility would have an ESQD established around it. Before a launch, a Launch Hazard Area (LHA) would be established. The LHA is the area that could be affected by missile debris should an explosion occur on or just above the launch area or in the event that the missile's flight must be terminated on the pad or just shortly after liftoff. This LHA is cleared of all non-mission essential personnel during launch operations to ensure personnel are not exposed to missile launch hazards.

Air Launch Targets

Air launches of target missiles may include target drones as described above for ground launch targets. However, for purposes of this analysis a typical Air Launch Target missile would use solid propellant boosters. The rocket motors for Air Launch Targets would be shipped from U.S. Government or contractor facilities by truck or air. Other components, such as the target/pallet assembly, would be shipped as applicable. When the target arrives at the test location, the motors would be assembled and the FTS installed and integrated with other components. The target reentry vehicle would be attached to the booster; then the booster, pallet and sled assembly, and support equipment would be loaded onto the aircraft.

Air Launch Targets would be launched from specifically configured U.S. Air Force cargo aircraft. Various target missile configurations could be used depending on the range needed for the particular test. The integrated target/pallet assembly would be loaded into

the aircraft and flown to a predetermined drop point. The target/pallet assembly would be pulled from the aircraft by parachute and dropped to a level between approximately 6,096 and 7,620 meters (20,000 and 25,000 feet) above mean sea level (MSL). The target would separate from the pallet and then descend via parachutes to approximately 4,100 meters (13,450 feet) above MSL. At this altitude, the parachutes would release the target, and motor ignition would occur during free-fall. After firing, the boosters would drop into predetermined areas in the ocean. The target would then follow its flight path to interception or to splash down within a designated ocean impact area. The target would be fitted with an FTS to terminate the flight if unsafe conditions develop.

Sea Launch Targets

Sea launches of target missiles would be conducted using specially configured missiles and any one of a number of sea-based platforms. The Sea Launch Target missile would consist of solid or liquid propellant boosters. The liquid propellant boosters can be either pre-fueled or non-pre-fueled. Target missiles and support equipment would be transported from U.S. Government storage depots or contractor facilities in accordance with Department of Transportation (DOT) regulations. They would be placed in secure storage until assembly and launch preparation. Applicable safety regulations would be followed in the transport and handling of hazardous materials. An appropriate ESQD would be established and maintained around facilities where ordnance is stored or handled.

Countermeasures

In Block 2004, the MDA would conduct activities that would contribute to the use of countermeasures in future Blocks. Dedicated flight tests of CM/CM, CM/CM-1 and CM/CM-2, would be conducted to support Block 2006/2008 system definition. During Block 2006 work would continue to improve existing countermeasure capabilities and provide new capabilities including development of payload suites for CM/CM flight tests and target risk reduction flights. The work completed during Block 2008 would represent a major step in the BMDS evolution. As target development matures, capability-based targets and payload suites (to include new and more complex countermeasures) would be developed, tested, and integrated into the BMDS testing program. The technical details for Block 2010 are less defined than near-term Block efforts however, it is expected that progression on the development and use of increasingly realistic countermeasures would be incorporated into the BMDS testing activities.

Lethality

Lethality studies include the monitoring and analysis of threat payload destruction and dispersion resulting from intercepts of test threat missiles. Although limited testing is done on actual lethal or live agents under controlled conditions (i.e., in a certified

laboratory environment), the majority of testing relies on a number of payload "simulants." Testing would require the use of existing simulants and may require the use of newly developed simulants.

The MDA divides lethality into four areas of interest. The first is target response, which analyzes the actual ballistic missile intercept of a threat. The second is the formation of the debris cloud containing both pieces of the target and any payload surviving the intercept. The third looks at the atmospheric conditions for transport and dispersion of the debris cloud. Last, the lethality program examines where and how much of the debris, especially the payload, impacts the Earth.

Lethality tests include investigating the impact of the intercept of various threat payloads at various altitudes and speeds. This involves using a mix of laboratory experiments, field tests, flight tests of opportunity, models, and hydrocode simulations and computational analysis. One critical objective of lethality testing is to calculate weapons of mass destruction intercept effects and consequences. Intercepts would occur in the boost phase of target flight or in the endo- or exoatmosphere. Therefore, the altitude and speed of intercepts may affect the effectiveness of an intercept and fate and transport of threat payloads. Because the nature of an incoming threat payload is unknown, lethality testing would assist in establishing a methodology to allow warhead typing based on impact response.

Simulant payloads would be incorporated into targets already scheduled to participate in BMDS element and system flight tests. This "piggy-back" method of data collection allows for the observation of tests of opportunity and the gathering of post-engagement lethality information. Analysis would be done to determine the damage done to submunitions (for both high explosive and chemical payloads) from interceptor missile impact. Submunitions are individual containers in the target designed to distribute a threat payload to a wider area. Multi-wavelength sensors would be used to track and characterize the resulting intercept debris cloud and its eventual impact on the ground.

Testing would also include the study of lethality enhancers, which aim to increase the kill radius of an interceptor missile. Examples of lethality enhancers could include additional explosives or tungsten pellets that explode out of the interceptor upon impact. In some cases, the additional explosives are included in the interceptor missile's FTS. Data collected from these tests would be used to continue to refine existing core lethality models. These studies are currently being conducted at federally funded research development centers, academic institutions, and DoD facilities in the U.S. and abroad. Simulated bulk chemicals can be dispersed upon impact with the interceptor and/or by using an explosive device. Using an explosive charge in the payload can enhance the dispersion of the chemicals, and thereby reduce the concentration of the simulant before it reaches ground level. In the event of a missed intercept, a termination device may be used to disperse the chemicals.

In Block 2004, the MDA would focus on resolving lethality questions and concerns for bulk chemical targets with simulants while transitioning to a greater focus on validating physical phenomena with full-scale flight-test data. This would include activities such as collecting data and analyzing various chemical agents and their simulants. Experiments would investigate the in-situ negation and breakup of simulants with a focus on boost and terminal phase intercepts. Lethality tests in future Blocks have yet to be determined but would involve similar tests based on prior block experiences and individual component and integrated testing plans.

2.3.3 Deployment of the BMDS

The U.S. would incrementally expand the functional capabilities of the BMDS by deploying components and elements as testing demonstrates that they are sufficiently capable of defending against threat ballistic missiles. Generally, a component would be deployed after it has been sufficiently developed and tested to demonstrate that it is capable of operating successfully within an integrated BMDS and the associated safety and health procedures are developed and deemed adequate.

The DoD is planning to use Missile Defense Test Bed assets to defend the U.S. when it has been determined that they provide a militarily useful defensive capability. However, the MDA could deploy individual developmental assets on an emergency basis, may field elements in limited numbers should it be determined that the prototype or test article had the potential to provide a militarily useful and sustainable capability, or the asset could be deployed if directed in support of national interests.[31] Components deployed on an emergency basis would function as partially integrated components of the BMDS until the emergency situation ends.

Deployment involves a series of actions to prepare the component or element to function in its defensive position and maintain a state of readiness to address missile threats. Deployment would involve fielding and sustainment activities as described below.

Development activities include acquiring components and planning for possible transfer to military services. As the missile defense acquisition agency, the MDA would be responsible for the purchase of developmental components and engaging the military services and Combatant Commands regarding their uses and sustainment. DoD decides that a military service will engage in component production with procurement funds. The MDA, through its development contractors, could build or assemble the component and the associated support assets needed for operation in the field. The MDA would engage the operating Combatant Command and the military service in transition planning to address roles and responsibilities regarding timing, resourcing, and other requirements.

[31] On December 17, 2002, President Bush directed the fielding of IDO capabilities by 2004, which would provide limited protection to defend the U.S. against ballistic missile attack. In October 2004, MDA achieved LDC when certain BMDS test components could also be placed on alert and used in defensive operations.

The military service and MDA would agree in writing on roles and responsibilities regarding the fielding of the components to include the preparation of the deployment site, transport of the component to the deployment site, installation and test in a field environment, and staffing the deployment sites. Preparing the deployment site includes facilities acquisition and related logistics functions that might be required to support the component in its fielded state. DoD direction to transfer the component to a service would establish the functions performed by MDA, the military service, and the Combatant Command(s). In the absence of an agreed to transition plan, or a DoD transfer decision, the MDA would operate and maintain the component.

Sustainment includes various maintenance and operating activities, including maintaining components in a ready state by conducting routine maintenance, repairing damaged or defective parts, testing the component's readiness, and resupplying the component with necessary materials. Component upgrades and service life extensions, as well as training operation personnel, also are sustainment activities.

Future deployment of BMDS components would occur at times and places where the deployed component would provide the most useful defensive capability to counter existing or emerging threats. This could include sites outside the continental U.S. The following subsections discuss potential deployment actions associated with each aspect of the deployment process (acquiring, fielding, transfer, and sustainment) that are considered in this PEIS.

2.3.3.1 Fielding BMDS Components

The MDA or a military service would obtain components for deployment by purchasing the components and their parts, and assembling the parts either on site or in an assembly facility, by transferring unused units originally planned for testing, or by ordering additional units from the manufacturer. Generally, the components would be manufactured by the same contractor and assembled in the same facilities where the units were manufactured and assembled for the testing program. However, the MDA or a military service would acquire the components from other sources if the existing contracts expire and a subsequent contract is awarded to another successful offeror. This PEIS assumes that components continue to be built by the existing development contractors at the same facilities because predictions of contract changes are speculative. All manufacturing would be conducted at facilities that are subject to Federal, state, and local environmental regulations. Construction of new facilities would be subject to all applicable requirements of NEPA, EO 12114, and other relevant Federal, state, and local environmental laws and regulations, as appropriate.

Fielding would include construction of facilities, transportation and installation of equipment, and training with the integrated components of the proposed BMDS.

Deployed components would be fielded at a number of locations to provide an integrated and evolutionary BMDS. Additional capabilities would be added to expand the BMDS as the technology develops. Components would be fielded at locations where they provide a layered defense against all phases of missile flight. Boost phase defense components would be fielded where they can operate in close proximity to potential threat missile launch sites. Midcourse defense components would be fielded at locations near potential missile flight paths. Terminal defense components would be fielded near theaters of operation, near major U.S. cities and other potential targets, and on allied territory.

The MDA or a military service would field components as directed by the DoD to provide a BMDS to counter a wider range of threats. Fielding of components requires several actions to move personnel and materials to the fielding site, prepare the site, place the component at the site, and to activate the component. Exhibit 2-23 summarizes typical fielding activities for the potential platforms.

Exhibit 2-23. Typical Fielding Activities

Platforms	Components	Typical Fielding Activities
Fixed and Mobile Land-based	Weapons, Sensors, C2BMC, Support Assets	▪ Site layout and clearing ▪ Facility construction, operation and maintenance ▪ Utility construction (electric, water, sewer, fiber optics, etc.) ▪ Material transport (truck, rail, air, ship) ▪ Waste management ▪ Human services (lodging, eating, work space)
Fixed and Mobile Sea-based	Weapons, Sensors, C2BMC, Support Assets	▪ Facility (e.g., dock, port) construction, operation and maintenance ▪ Utility construction (electric, water, sewer, fiber optics, etc.) ▪ Material transport (truck, rail, air, ship) ▪ Waste management ▪ Human services (lodging, eating, work space)
Mobile Air-based	Weapons, Sensors, C2BMC, Support Assets	▪ Airport and support facility construction, operation and maintenance (e.g., chemical plant) ▪ Utility construction (electric, water, sewer, fiber optics, etc.) ▪ Material transport (truck, rail, air, ship) ▪ Waste management

Exhibit 2-23. Typical Fielding Activities

Platforms	Components	Typical Fielding Activities
		▪ Human services (lodging, eating, work space)
Mobile Space-based	Weapons, Sensors, C2BMC, On Ground Support Assets	▪ Weapon or sensor construction ▪ Material transport (truck, rail, air, ship) ▪ Rocket launch ▪ Support facility construction, operation, and maintenance

In conjunction with combatant commanders, the MDA is planning to activate test assets (e.g., missiles, launchers, sensors, and C2 components) to provide continuous or near continuous defense of the U.S. The ongoing activities in support of the IDO at Vandenberg AFB and Fort Greely are illustrative of the site preparation activities that would be performed by the MDA when a component is fielded. The IDO fielding activities, and future fielding activities, would use existing facilities and infrastructure to the extent possible to minimize new construction. Site preparation at the two locations includes

- Construction of new or modified launch facilities and silos;
- Installation of sensors, fire control center, and C2BMC facilities;
- Development of missile assembly and launch preparation facilities;
- Development of facilities to store liquid propellants (fuel and oxidizers) and hazardous wastes;
- Installation of communication cables in existing conduits or new trenches, sensor hardstands, and antennae;
- Upgrade of electric power lines, installation of backup generators, and upgrades to water and sewer hookups as needed;
- Modification of existing or construction of new buildings to provide storage, maintenance, administrative space, security facilities, and housing;
- Upgrade of existing roadways and parking facilities, and
- Installation of security equipment.

The DoD transferred the PAC-3 program and realigned the MEADS program from MDA to the Department of the Army on February 5, 2003. As part of that transfer and realignment, MDA retained the responsibility for further research, development, test and evaluation, target development, future Block capability flight-testing, and software improvements to improve and maintain interoperability with C2BMC. This PEIS assumes that the MDA would retain similar responsibilities during future transfers to the military services.

2.3.3.2 Sustainment of BMDS Components

Sustainment of BMDS components includes operation, maintenance and repair, upgrades and service life extensions. MDA would operate deployed components until they are transferred to a service. Operation would include the consumption of fuel and power and generation of wastes. MDA and/or contractor personnel would conduct routine maintenance and repair on deployed components prior to transfer to a service. After transfer to a service, sustainment of components would be the responsibility of the appropriate service. Routine maintenance would primarily occur at the fielding location unless safety or environmental constraints necessitated a change in location.

2.3.4 Planning for Decommissioning of the BMDS

Decommissioning would involve the planning for the final demilitarization and disposal of the BMDS components and support assets no longer needed for the BMDS or its testing program. Decommissioning occurs when components reach the end of their effective service life, when technological advances render them obsolete, or when changes to the threat environment render them unnecessary at a location. Demilitarization is the act of destroying a system's offensive and defensive capabilities to prevent the equipment from being used for its intended military purpose. Demilitarization of the components would be performed in accordance with the DoD Directive 4160.21-M, *Defense Reutilization and Disposal*; DoD Directive 4160.21-M-1, *Defense Demilitarization Manual*; procedures developed by MDA or the responsible military service; and applicable Federal, state, and local regulations and procedures.

Disposal is the process of redistributing, transferring, donating, selling, abandoning, destroying, or any other disposition of the property. Disposal of components would involve establishing the availability of disposal facilities and then shipping hardware and materials to the disposal site. Disposal of materials would then conform to DoD directives, Joint Service Regulations, and comply with all applicable Federal and state laws.

Decommissioning processes will vary for weapons, sensors, C2BMC, and support assets and will be performed by the appropriate DoD agent. The following list describes the decommissioning activities that would be performed for each of the components in the proposed BMDS.

- **Weapons.** Decommisioning of weapon components would involve transferring the equipment to other uses or demilitarization in accordance with the appropriate requirements.

- **Sensors.** If sensor equipment is only needed for testing purposes and would not be used in the BMDS architecture, decommissioning would involve returning the

equipment to the responsible military service. If the equipment would be used in the BMDS architecture, decommissioning of sensors would include recycling/reuse or disposal or unused and residual materials, in accordance with the appropriate requirements. Additionally, assets can be converted to another MDA use, transferred to a military service, or sold. Space-based sensors would be decommissioned by being abandoned in orbit, parked in higher orbit, deorbited, retrieved, or reprogrammed for alternate uses.

- **C2BMC.** As technology advances and BMDS needs evolve, upgrades of C2BMC hardware and software would likely be necessary. C2BMC equipment that is replaced would be decommissioned in accordance with appropriate requirements.

- **Support Assets.** Decommissioning of equipment, infrastructure, and test assets would involve continued or adaptive use by the DoD or other government agencies, or performance of any necessary decontamination activities in the event the fixed asset will no longer be used, followed by sale. In the event of decommissioning, utilities could be left in place if the potential to use them for future DoD or other purposes existed. Mobile test or support assets would be refurbished and transferred to an alternate use, demilitarized, or dismantled and disposed. In terms of MDA BMDS Programs, aspects of particular MDA programs could be decommissioned by transferring them to another government agency, selling them, removing and using specific parts (i.e., sensors), or storing them at a government airfield. Each individual program also may have particular decommissioning activities associated with it.

Decommissioning could involve complete termination of operations and disposal of the system or its replacement with a new or upgraded system. Individual components would be removed from test ranges and test facilities at the conclusion of the testing activities. Testing facilities could also be decommissioned when they are no longer needed for the BMDS testing program.

Prior to decommissioning components, the MDA would evaluate the components for continued use by other U.S. Government agencies (e.g., U.S. Customs, U.S. Department of the Treasury) or as candidates for Foreign Military Sales. Various adaptive reuses would be analyzed and implemented if appropriate. If no adaptive reuses were identified, the units would be demilitarized and disposed as excess to the needs of the Government.

2.4 Alternatives

This PEIS considers two alternative approaches to providing the layered integrated BMDS program described in sections 2.1, 2.2, and 2.3. MDA analysis of the threat environment (potential launch locations, missile flight paths, and target locations) concludes that an effective missile defense should include weapons components based on at least the land, sea, and air. The addition of a space-based weapons platform would

provide another layer of missile defense capability. Providing only one or two weapons platforms would either leave areas unprotected or reduce the opportunities to engage threat missiles.

2.4.1 Alternative 1 – Implement Proposed BMDS with Land-, Sea-, Air-based Weapons Platforms

In Alternative 1, the MDA would develop, test, deploy, and plan to decommission land-, sea- and air-based platforms for BMDS weapons components and related architecture and assets. The BMDS envisioned in Alternative 1 would include space-based sensors, but would not include space-based weapons.

This section describes components and associated activities that would occur during each stage of the acquisition life cycle (development, testing, deployment, and decommissioning) under Alternative 1. Individual components would be developed and tested to determine the adequacy for deployment, that is, military utility and ability to function in an integrated BMDS. In addition, the BMDS C2BMC architecture would be designed and tested to meet the needs of an integrated system. Components deemed capable of integrated BMDS activities would be deployed and decommissioned as needed.

2.4.1.1 Alternative 1 - Development

Weapons subcomponents such as boosters, kill vehicles, and lasers would be derived from the existing and proposed elements. Development of the BMDS components as described in Section 2.3.1 for Alternative 1 would involve the following weapons components based on land, sea, and air operating environments

- Land – GMD GBI; THAAD; PAC-3; AWS; MEADS; KEI
- Sea – Aegis BMD; KEI
- Air – ABL

Development of BMDS sensors would build on existing sensors and infrastructure on land, sea, air and space operating environments. The development of C2BMC and support assets would be closely linked with the development of other components. The C2BMC is designed to mold components into a complementary and synergistic system-of-systems. Ongoing development of BMDS components is required to meet evolving functional capabilities. The main types of development activities include planning, budgeting, research and development, systems engineering, maintenance and sustainment, manufacture and initial testing of prototype test articles, and conduct of tabletop exercises.

New technologies are continuously being considered by the MDA's Advanced Systems program and by Systems Engineering Directorate within the MDA in concert with the National Team. The technologies and programs underway are discussed in Appendix F.

2.4.1.2 Alternative 1 - Testing

Testing activities, as discussed in Section 2.3.2, comprises the majority of activities under Alternative 1. Testing of the BMDS components and elements provides system characterization, verification, and assessment. Systems integrated tests rest on a foundation of component and element level tests, which were described in previous environmental documentation. This PEIS analyzes System Integration Tests including Modeling, Simulation and Analysis, integrated missile defense wargames, MDIEs, GTs and SIFTs. For the purposes of this analysis, all integrated tests with the exception of the SIFTs involve only ground-based components. The SIFTs could include a combination of any of the existing or planned land-, sea-, or air-based weapons components, and any land-, sea-, air- or space-based sensors and support assets. Integrated testing would determine the ability of the evolving C2BMC to integrate the BMDS components. The SIFTs will be discussed in terms of existing and reasonably foreseeable test scenarios. Existing SIFTs leverage currently scheduled element tests. Future SIFTs would be developed with increasing fidelity and complexity. SIFTs would involve the launch of at least one target missile to be negated by either an interceptor missile or a laser. Several sensor systems would acquire and track the target missile and interceptor missile (or ABL), as well as the actual intercept. For each planned test intercept, debris impact zones would be established. SIFTs could cross multiple environment types. Testing would occur within the confines of the U.S. and surrounding BOAs, as well as at some select locations abroad. As the proposed BMDS grows in capability, testing would expand to include more international sites.

2.4.1.3 Alternative 1 - Deployment

Under Alternative 1, the BMDS missile interceptors and directed energy missile defense system components, and related architecture and assets would be deployed on land-, sea- and air-based platforms. See Section 2.3.3 for a discussion of Deployment as part of the acquisition life cycle. Because the BMDS is envisioned to be an evolving system with interchangeable interoperable components, there is no final architecture defined for the system. Deployment would require fielding and sustainment of BMDS components in the U.S. and at strategic locations abroad. Components would be deployed as they are deemed capable of functioning within the BMDS. Fielding activities such as manufacturing, site preparation and construction and transport of components to deployment sites would be required. Sustainment activities include operation and maintenance of components, training, upgrades, and service life extensions where appropriate.

2.4.1.4 Alternative 1 - Planning for Decommissioning

Decommissioning would involve the planning for the final demilitarization and disposal of the BMDS components and support assets no longer needed for the BMDS or its testing program (see Section 2.3.4). Plans for decommissioning BMDS components and facilities would be incorporated into site development activities. Under Alternative 1, decommissioning of weapons would involve the removal and disposal of rocket propellant and dismantlement and disposal of residual materials such as the missile shell. Both testing as well as deployed components and facilities may be decommissioned. Thus, target missiles would undergo similar decommissioning processes.

Decommissioning of sensors would include the recycling/reuse and disposal of residual materials associated with the antennae, electronic, cooling and power units. Space-based sensors would be abandoned in orbit, parked in a higher orbit, deorbited, retrieved, or reprogrammed for alternate uses. C2BMC hardware and software would be upgraded or removed and disposed according to applicable requirements. Fixed facility support assets would be assigned new missions, returned to their owners, or transferred to new owners. Mobile support assets such as transportation vehicles, missile launchers and launch vehicles would be refurbished and transferred to an alternate use, or dismantled and disposed.

2.4.2 Alternative 2 – Implement Proposed BMDS with Land-, Sea-, Air- and Space-based Weapons Platforms

In Alternative 2, the MDA would develop, test, deploy and plan to decommission land-, sea-, air- and space-based platforms for weapons and related architecture and assets. Alternative 2 would be identical to Alternative 1, with the addition of space-based defensive weapons. A space-based test bed would be considered and evaluated to determine the feasibility of using kinetic energy to intercept threat missiles from space.

This section describes the space-based weapons components and associated acquisition life cycle activities under Alternative 2. Individual components would be tested to determine the adequacy for military utility and ability to function in an integrated BMDS. In addition, the BMDS C2BMC architecture would be designed and tested to meet the needs of an integrated system.

2.4.2.1 Alternative 2 - Development and Testing

MDA is developing an exoatmospheric kill vehicle (EKV), which, as described in Section 2.2.1, acts as the kinetic energy weapon on an interceptor. EKVs could be launched as hit-to-kill weapons from a space-based platform. Under Alternative 2, the KEI is a potential space-based defensive weapon to counter threat ballistic missiles during boost phase. The development of midcourse and terminal phase defensive

weapons may be included as well. The new interceptor would have effectiveness similar to earlier interceptors but would achieve it by decreasing the mass of the interceptor and increasing the speed at which the interceptor travels. This interceptor may use existing or new boosters; however, a new EKV would likely be designed for the interceptor. The EKV would be adaptable and could be launched from a space-based platform. Testing of a space-based weapons platform would involve ground-based testing including modeling and simulations of space-based technology, as well as multiple launches to emplace prototype technology in orbit. The prototype would then be tested in increasing realistic scenarios involving simulated and actual intercepts of targets. The Near-field Infrared Experiment (NFIRE) spacecraft could be launched on a Minotaur space launch vehicle from Wallops Flight Facility. The spacecraft bus would be shipped unfueled; however, the payload would be shipped fully fueled from the manufacturer. Spacecraft integration with the booster would also occur at Wallops Flight Facility.

2.4.2.2 Alternative 2 - Deployment

MDA would deploy EKVs and space-based launch platforms to deploy a space-based weapons component, currently envisioned as the KEI. The MDA would also obtain launch services to deploy the launch platform satellite and weapons components into their orbits. They could use Evolved Expendable Launch Vehicles launched from Vandenberg AFB and Cape Canaveral.

2.4.2.3 Alternative 2 - Planning for Decommissioning

A space-based weapons platform resembling a satellite would be decommissioned by being abandoned in orbit, parked in a higher orbit, deorbited, or retrieved. A weapons platform carrying a sensor system could have alternate uses including monitoring rocket launches and aircraft flights. MDA or the military services would make decisions on the disposition of the space-based weapons platforms based on the stability of the orbits, the costs and risks of deorbiting or retrieval, the remaining useful life of the equipment, and potential for alternate uses.

2.5 No Action Alternative

Under the No Action Alternative, the MDA would not test, develop, deploy, or plan for decommissioning activities for an integrated BMDS. Instead, the MDA would continue existing test and development of discrete missile defense systems as stand-alone defensive capabilities.

Under the No Action Alternative, individual components would continue to be tested to determine the adequacy of their stand-alone capabilities, but would not be subjected to integrated system-wide tests. In addition, the C2BMC architecture would be designed

around the needs of individual components and would not be designed or tested to meet the needs of an integrated system.

The approach and methods for deployment and decommissioning of components under the No Action Alternative would be the same as under the proposed action. However, deployment of individual components could occur earlier under the No Action Alternative because they would not undergo System Integration Testing. In addition, a greater number of units of the components may need to be deployed to provide a comparable number of opportunities to intercept threat missiles as provided by an integrated system.

Failure to deploy a fully integrated BMDS could result in the inability to respond to a ballistic missile attack on the U.S. or its deployed forces, allies and friends in a timely and successful fashion. This could result in the successful attack on one or more large population centers with chemical, biological, or nuclear weapons of mass destruction. The threat of such an attack could also jeopardize national security interests. Further, this alternative would not meet the purpose of or need for the proposed action or the specific direction of the President and the U.S. Congress.

2.6 Alternatives Considered But Not Carried Forward

2.6.1 Cancel Development of Ballistic Missile Defense Capabilities

As suggested to the MDA during the scoping process, one alternative would involve canceling the development of all ballistic missile defense capability development and testing. Such an alternative would rely upon diplomacy and military measures to deter missile threats against the U.S. However, this proposed alternative would eliminate the capability to defend the U.S., its deployed forces, allies, or assets from a ballistic missile attack should diplomacy or other deterrents fail. This alternative does not meet the purpose of or need for the proposed action as described in Sections 1.3 and 1.4, respectively; does not meet the direction of the President and the U.S. Congress; and therefore will not be analyzed further.

2.6.2 Single or Two-Platform BMDS

MDA has evaluated the threat environment (potential launch locations, missile flight paths, and target locations) and concluded that an effective missile defense should include components based on at least the land, sea, and air. Alternatives that provide only one or two platforms would reduce the capability of the BMDS to defend the U.S., its deployed forces, allies, or assets from a ballistic missile attack. This could result in the successful attack on one or more large population centers with chemical, biological, or nuclear weapons of mass destruction. The threat of such an attack could also jeopardize national security interests. Therefore, alternatives that provide a BMDS with only one or two platforms will not be carried forward for further analysis.

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3 AFFECTED ENVIRONMENT

Introduction

This Section discusses the biomes, ocean areas, and the atmosphere that comprise the Affected Environment in this PEIS, as well as the resource areas that could be impacted by the proposed action. This Section defines each resource area (Section 3.1) and discusses those resource areas within the context of a particular biome, ocean area or the atmosphere (Section 3.2).

The Affected Environment includes all land, air, water, and space environments where proposed activities are reasonably foreseeable. The Affected Environment considered in this PEIS includes specific locations in the U.S. and areas outside the U.S. As a result, applicable international treaties, foreign national laws and U.S. Federal, state, and local laws and regulations must be considered. The description of each resource area in Section 3.1 includes potentially relevant legal requirements and provides a roadmap of issues to consider for impacts assessment of a tiered document along with a determination of significance of the impacts. Appendix G contains additional information about laws and regulations that should be considered for subsequent impact analyses.

The Affected Environment for this PEIS examines global biomes[32] where development, testing, deployment, and planning for decommissioning activities for the proposed integrated BMDS may occur.

The biomes each cover a broad region, both geographically and ecologically. The distribution of global biomes is widely documented and accepted within the scientific community, and classification of biomes is based upon the characteristics of climate, geography, geology, vegetation, and wildlife.[33] Using biomes as affected environment designations captures the relevant differences between environments in a way that supports a useful analysis of impacts and allows future site-specific environmental documentation to tier from this PEIS. Note that there are no reasonably foreseeable BMDS activities occurring in Antarctica. For this reason, this continent does not appear on any of the biome maps in the PEIS.

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[32] Merriam-Webster defines biome as a major ecological community type (as tropical rain forest, grassland, or desert). (Merriam-Webster Online Dictionary, 2004)

[33] *Biogeography*, 2nd ed. James H. Brown and Mark V. Lomolino. Pages 110-111. Sinauer Associates, Inc. Publishers, 1998. (stating "[E]cologists and biogeographers have almost without exception classified terrestrial [ecosystems] on the basis of the structure or [natural features] of the vegetation.")

The Affected Environment in this PEIS is divided into nine terrestrial biomes, the BOA, and the Atmosphere as identified below.

- Arctic Tundra
- Sub-Arctic Taiga
- Deciduous Forest
- Chaparral
- Grasslands
- Desert
- Tropical
- Savanna
- Mountain
- BOA
- Atmosphere

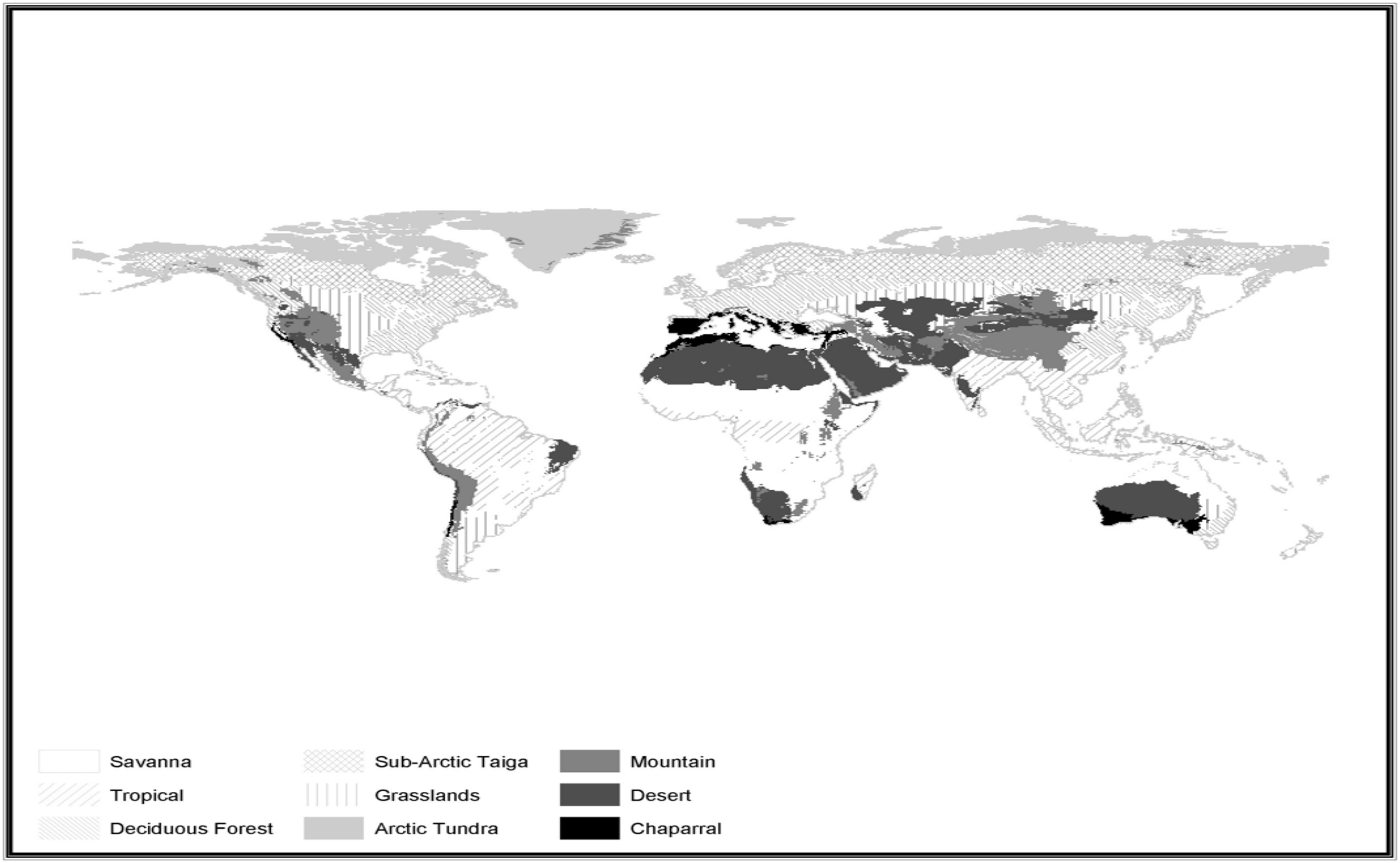
Exhibit 3-1 shows the global distribution of the various terrestrial biomes (not including the BOA and the Atmosphere). Biomes may be further subdivided based on geographic location; however, this PEIS considers nine overarching terrestrial biomes.

The characteristics (e.g., climate, geology, flora and fauna) that define a global biome are the same regardless of whether the biome area of concern is coastal or inland. However, unique features (e.g., wetlands, estuaries, wind currents, hurricanes) of coastal areas[34] may affect determination of environmental impacts. Therefore, the Affected Environment discusses these unique features within the biome descriptions. Describing coastal areas as part of the larger inland biomes minimizes repetition among the descriptions yet captures the important aspects of the coastal areas in a way suitable for impacts analysis.

Each biome description contains representative examples of past, current, or proposed locations used by the MDA within that biome. Therefore, an entity tiering from the PEIS would be able to map a particular site to its applicable biome. For example, WSMR in New Mexico is located within the Desert Biome. The description of the Desert Biome describes the particular characteristics of the biome that could affect the impacts of activities proposed at WSMR, or other locations in this biome.

[34] For the purposes of this PEIS, the coastal area includes the near shore, which is an indefinite zone extending seaward from the shoreline beyond the breaker zone, and is not coextensive with the area afforded protection under the Coastal Zone Management Act. This typically includes water depths of less than 20 meters (65 feet). The inland portion of the coastal area includes shoreline, tidal wetlands, coastal wetlands, and coastal estuaries.

Exhibit 3-1. Map of Global Biomes



Source: Modified From National Geographic, 2003b

- **Arctic Tundra Biome.** The Arctic Tundra Biome as described in Section 3.2.1 is located in areas above 60^{o} North latitude.[35] The areas of potential interest for the BMDS in the Arctic Tundra Biome include the arctic regions of North America and the arctic coastal regions that border the North Atlantic Ocean, North Pacific Ocean, and Arctic Ocean, including portions of Alaska, Canada, and Greenland (administered by Denmark).

- **Sub-Arctic Taiga Biome.** The Sub-Arctic Taiga Biome as described in Section 3.2.2 occurs between 50° to 60° North latitudes. The areas of interest in the Sub-Arctic Taiga Biome include the sub-arctic regions of North America and the sub-arctic coastal regions that border the North Pacific Ocean, including portions of Alaska.

- **Deciduous Forest Biome.** The Deciduous Forest Biome as described in Section 3.2.3 is located in the mid-latitude, which means that it is found between the Polar Regions and the tropics. The areas of interest in the Deciduous Forest Biome include the eastern and northwestern U.S. and portions of Europe.

- **Chaparral Biome.** The Chaparral Biome as described in Section 3.2.4 occurs on the west coastal regions of continents between 30° and 40° North and South of the equator. The Chaparral Biome areas of interest include a portion of the California Coast and the coastal region of the Mediterranean from the Alps to the Sahara Desert and from the Atlantic Ocean to the Caspian Sea.

- **Grasslands Biome.** The location of the Grasslands Biome as described in Section 3.2.5 is not limited to a particular latitude range. Instead, Grasslands occur in the middle of all continents, except Antarctica. The areas of interest in the Grasslands Biome include prairie regions of the Midwestern U.S.

- **Desert Biome.** The Desert Biome as described in Section 3.2.6 is located between 15° and 35° North and South of the equator. The area of interest in the Desert Biome includes the western arid environment of the southwestern U.S.

- **Mountain Biome.** The Mountain Biome as described in Section 3.2.7 occurs in areas with high elevations just below and above the snow line of a mountain. The area of interest in the Mountain Biome includes the Rocky Mountains in the western U.S. and the Alps in central Europe.

[35] The latitudinal designations identify the general location for each biome; however, the biomes do not have rigid edges that begin and end at these latitudes. Therefore, there may be some overlap of biomes at or near these latitudinal designations.

- **Tropical Biome.** The Tropical Biome as described in Section 3.2.8 occurs between the Tropic of Cancer (23.5° North) and the Tropic of Capricorn (23.5° South). The area of interest in the Tropical Biome includes the Hawaiian Islands.

- **Savanna Biome.** The Savanna Biome as described in Section 3.2.9 occupies latitudes between 5º and 20º North and South of the equator. The area of interest in the Savanna Biome includes northern Australia.

- **Broad Ocean Area (BOA) Environment.** For the purposes of this PEIS, the BOA Environment as described in Section 3.2.10 includes the Pacific Ocean, the Atlantic Ocean, and the Indian Ocean.

- **Atmosphere Environment.** The Atmosphere Environment as described in Section 3.2.11 includes the atmosphere that envelops all areas of the Earth and consists of four principal layers: troposphere, stratosphere, mesosphere, and ionosphere (or thermosphere).

The description of the Affected Environment must be specific enough to allow meaningful assessment of potential impacts, yet broad enough to encompass all potential locations. The information in this Section and analysis in Section 4 do not purport to address site-specific issues. Additional analyses may be required to determine site-specific impacts for a proposed action.

The Affected Environment is discussed in terms of the following resource areas: air quality; airspace; biological resources; cultural resources; environmental justice; geology and soils; hazardous materials and hazardous waste; health and safety; land use; noise; socioeconomics; transportation; utilities; visual resources; and water resources. These areas represent the resources that the proposed BMDS may impact and were identified based on review of previous environmental documentation for the MDA, the DoD, and other agencies that conduct activities similar to those proposed for the BMDS (e.g., U.S. Air Force, NASA, FAA).

Definitions and descriptions are provided below for each resource area followed by a discussion of the issues that an impact assessment should address. Some resource areas are not analyzed in Section 4 of this PEIS, because they depend upon local factors and conditions and are too dependent on local information requirements to discuss meaningfully at a programmatic level. These resource areas include: cultural resources, environmental justice, land use, socioeconomics, utilities, and aesthetics (visual resources).

3.1 Resource Areas

3.1.1 Air Quality

Definition and Description

Air quality is determined by the type and amount of pollutants emitted into the atmosphere, the size and topography of the air basin, the prevailing meteorological conditions, and the location of sensitive receptors relative to the source of the emission of air pollutants. Air pollutants of concern fall into four categories.

- **Criteria Air Pollutants**. These are a group of seven pollutants identified in the Clean Air Act for which the U.S. EPA is required to establish allowable concentrations in ambient air: sulfur dioxide (SO_2), carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (including the compounds that contribute to its formation - volatile organic compounds [VOCs] and nitrogen oxides [NO_X]), particulate matter (PM) with a diameter of less than ten microns (PM_{10}), particulate matter of with a diameter of 2.5 microns or less ($PM_{2.5}$), and lead.

- **Hazardous Air Pollutants (HAPs)**. These are a group of 188 chemicals identified in the 1990 Clean Air Act Amendments (40 U.S.C. 7412(b)). Exposure to these pollutants has been determined to cause or contribute to cancer, birth defects, genetic damage, and other adverse health effects. Examples of HAPs include benzene, asbestos, and carbon tetrachloride.

- **Mobile Source Air Toxics**. These are a group of 20 HAPs plus "diesel PM and diesel exhaust organic gases," which are complex mixtures that contain numerous HAPs.

- **Regional Haze Pollutants**. The principle air pollutants that cause regional haze are SO_2, NO_X, VOC, PM_{10}, $PM_{2.5}$, and ammonia. The fraction of PM in the $PM_{2.5}$ size range is the most active component of PM in visibility degradation. SO_2, NO_X, VOC, and ammonia all undergo chemical transformations that result in the formation of sulfate, nitrate, and organic aerosols in the fine size range.

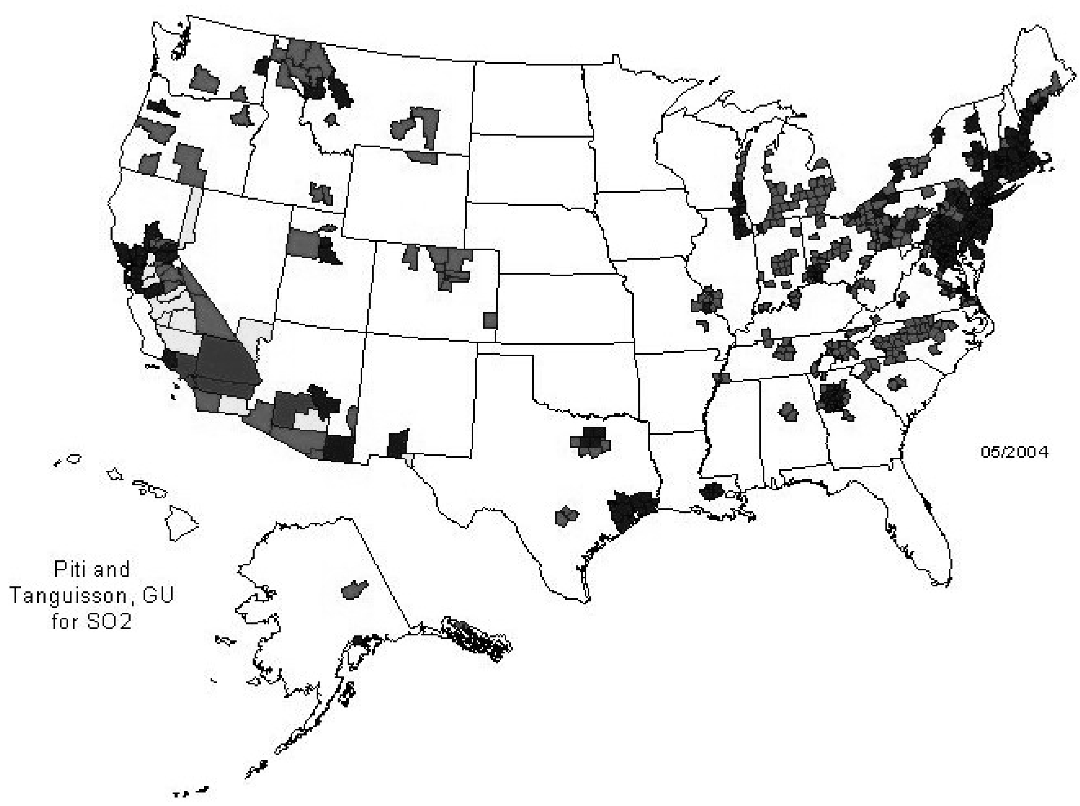
Sources of air pollutants include stationary sources (e.g., industrial facilities, refineries, power plants, launch pads), area sources (which are a collective representation of sources not specifically identified), mobile sources (e.g., motor vehicles, ships, aircraft, off-road engines, mobile platforms), and biogenic (natural) sources (e.g., forest fires, volcanoes).

The size and topography of the air basin, as well as the prevailing meteorological conditions determine how air pollutants are dispersed. Air currents carry secondary

pollution from one region to another, often increasing the background levels of air pollutants for the recipient regions. Such conditions are addressed in the Clean Air Act Section 184, which defines an Ozone Transport Region that includes Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, and Washington D.C. The emission standards are more protective in Ozone Transport Regions. An example of secondary pollution would be ozone (smog) created when NO_X and VOCs react in the presence of sunlight. The NO_X and VOCs could be released into the atmosphere a long distance from where the ozone ultimately degrades the air quality.

The Clean Air Act (42 U.S.C. 7401) requires the adoption of National Ambient Air Quality Standards (NAAQS) to protect the public health, safety, and welfare from known or anticipated effects of criteria air pollutants. According to EPA guidelines, an area with air quality better than the NAAQS is designated as being in attainment, while areas with worse air quality are classified as non-attainment areas. Pollutants in an area may be designated as unclassified when there are insufficient data for the EPA to identify attainment status. Current non-attainment areas in the U.S. are indicated in Exhibit 3-2.

Exhibit 3-2. Non-Attainment Areas for Criteria Pollutants January 2004



Note: Map is shaded by county to indicate the number of criteria pollutants for which the county is in non-attainment. However, the purpose of this exhibit is to generally illustrate the location of non-attainment areas in the U.S.

Source: EPA, 2004

The official list of non-attainment areas and a description of their boundaries can be found in the CFR at 40 CFR Part 81 and pertinent FR notices. EPA maintains an unofficial list on the Internet at http://www.epa.gov/oar/oaqps/greenbk/. As of February 2004, there were 68 non-attainment and 69 maintenance areas for ozone, 59 nonattainment and 24 maintenance areas for PM_{10}, 11 nonattainment and 65 maintenance areas for CO, 22 nonattainment and 30 maintenance areas for SO_2, and eight maintenance areas for lead.

For areas that are designated non-attainment, the Clean Air Act establishes levels and timetables for each region to achieve attainment of the NAAQS. States must prepare a State Implementation Plan (SIP), which documents how the region will reach its attainment levels by the required date. The SIP includes inventories of emissions within the area and establishes emissions budgets that are designed to bring the area into compliance with the NAAQS. In maintenance areas, the SIP documents how the state intends to maintain compliance with NAAQS.

Section 176(c) of the Clean Air Act prohibits Federal entities from taking actions in non-attainment or maintenance areas that do not "conform" to the SIP. The purpose of the conformity regulation is to ensure that Federal activities 1) do not interfere with the budgets in the SIPs; 2) do not cause or contribute to new violations of the NAAQS; and 3) do not impede the ability to attain or maintain the NAAQS. In November 1993, EPA promulgated two sets of regulations to implement CAA section 176(c):

- The Transportation Conformity Regulations, which establish the criteria and procedures for determining that transportation plans, programs, and projects funded under Title 23 U.S.C. or the Federal Transit Act conform to the SIP. The transportation conformity regulations are codified in 40 CFR 93, in Subpart A.

- The General Conformity Regulations, which ensure that other Federal actions also conform to the SIPs, and are applicable to all other Federal actions not covered under Transportation Conformity. The General Conformity regulations are codified in 40 CFR 93, Subpart B. All Federal actions are covered unless otherwise exempt (such as actions covered by transportation conformity, exempt actions listed in the rule, and cases where the action does not create emissions above the *de minimis* threshold levels specified by EPA regulations in 40 CFR 93.153(b)).

The proposed action is subject to the General Conformity Regulations, not Transportation Conformity Regulations. Under the General Conformity Regulations, MDA is required to determine whether the proposed action and alternatives would result in emissions within a non-attainment or maintenance area that would exceed established *de minimis* levels or would be regionally significant (i.e., exceed ten percent of the emission inventory). If so, MDA must make a General Conformity Determination in accordance

with EPA requirements. Exhibit 3-3 shows *de minimis* levels of pollutants for various non-attainment levels.

Exhibit 3-3. General Conformity *De Minimis* Levels

Criteria Pollutant	Area Designation	Pollutant	*De Minimis* Level, metric tons per year (tons per year)
Ozone	Extreme Non-attainment	NO_X or VOC	9 (10)
	Severe Non-attainment	NO_X or VOC	23 (25)
	Serious Non-attainment	NO_X or VOC	45 (50)
	Other Non-attainment with Transport	NO_X	91 (100)
	Other Non-attainment with Transport	VOC	45 (50)
	Other Non-attainment without Transport	NO_X or VOC	91 (100)
	Maintenance	NO_X	91 (100)
	Maintenance with Transport	VOC	45 (50)
	Maintenance without Transport	VOC	91 (100)
PM_{10}	Serious Non-attainment	PM_{10}	64 (70)
	Moderate Non-attainment	PM_{10}	91 (100)
	Maintenance	PM_{10}	91 (100)
CO	Non-attainment or Maintenance	CO	91 (100)
SO_2	Non-attainment or Maintenance	SO_2	91 (100)
NO_2	Non-attainment or Maintenance	NO_2	91 (100)
Lead	Non-attainment or Maintenance	Lead	23 (25)

Source: 40 CFR 93.153(b)

The Clean Air Act lists 188 HAPs, which are individual chemicals or elements that have been linked to observed human health effects such as increased risk of cancer, damage to the immune system, neurological problems, damage to reproductive systems (e.g., reduced fertility) and developmental systems, respiratory damage, and other health problems. Details on precisely how each HAP affects humans can be found in EPA's Integrated Risk Information System, a database available to the public.[36] The elemental

[36] EPA, 2003c

HAPs are primarily metals and families of metallic compounds (e.g., mercury compounds, arsenic compounds). The remaining HAPs are primarily organic compounds and selected inorganic gaseous compounds. Benzene, ethyl chloride, and pentachlorophenol are examples of organic HAPs. Hydrochloric acid and hydrogen fluoride are examples of inorganic HAPs.

The Clean Air Act regulations include a regional haze rule (64 FR 35714 [July 1, 1999]) that requires states to develop SIPs to address visibility at designated mandatory Class I areas, including 156 designated national parks, wilderness areas, and wildlife refuges. General features of the regional haze rule are that all states are required to prepare an emissions inventory of all haze related pollutants from all sources in all constituent counties. Most states will develop their regional haze SIPs in conjunction with their $PM_{2.5}$ SIPs over the next several years.

Another concern with respect to air quality is greenhouse gas emissions. The primary greenhouse gas emitted by anthropogenic or human-derived activities in the U.S. is CO_2, which represented approximately 84 percent of total greenhouse gas emissions in 2001. The largest source of CO_2, and of overall greenhouse gas emissions, is fossil fuel combustion, both from stationary (power plants, industry and manufacturing processes) and mobile sources (automobiles, trucks, construction equipment, lawn mowers). Electric power generation, from utilities and non-utilities combined, accounted for the largest source of U.S. greenhouse gas emissions in 2001, closely followed by transportation sources and industrial processes. On an annual basis, the overall consumption of fossil fuels in the U.S., and therefore emissions from the combustion of those fuels, generally fluctuates in response to changes in general economic conditions, energy prices, weather (temperature extremes during winters and summers), and the availability/acceptance of non-fossil fuel alternatives.

Although CO, NO_X, VOCs, and SO_2 do not have a direct global warming effect, they are regulated because of their role in influencing the formation and destruction of tropospheric (ground-level) and stratospheric (upper atmosphere) ozone. CO is produced when carbon-containing fuels are combusted incompletely. NO_X (i.e., nitrogen oxide [NO] and NO_2) originate predominantly from fossil fuel combustion, with the majority of emissions from mobile sources, but also from stationary sources. VOCs, which include hundreds of organic compounds that participate in atmospheric chemical reactions, are emitted primarily from transportation, industrial processes, and non-industrial consumption of organic solvents. In the U.S., SO_2 is primarily emitted from coal combustion for electric power generation and from the metals industry. (EPA, 2003b)

Impact Assessment

MDA activities that would contribute to air quality impacts include actions that emit criteria pollutants, HAPs, mobile source air toxics, or regional haze pollutants, as well as

compounds that would affect climate change. MDA actions that would result in the emission of such pollutants and compounds include missile launches, operation of internal combustion and jet engines, incineration, heating and cooling of facilities and components, use of fuel storage tanks, fueling activities, and construction. Best available control technologies are applied to new emissions sources and to sources that are modified to minimize the effects that MDA activities would have on air quality. Impacts on the regulated local and regional air quality from activities related to the proposed BMDS would result from construction and operation activities at specific locations, launch related activities, and other general activities. The emission of CO_2 and ozone-depleting substances associated with the proposed BMDS has the potential to result in climate change impacts.

Construction and Operations Activities

Emissions resulting from site preparation and construction activities as well as new or increased operations activities would include PM, CO, NO_X, sulfur oxides (SO_X), and VOC. The use of construction and supply equipment may increase all types of emissions. Emissions due to new or increased site operations activities would result from

- Increase in overland shipments related to new or increased operations;
- Use of new equipment and generators or increased use of existing equipment and generators;
- Relocation of support personnel and localized increase in commuter traffic;
- Use of new fuel storage facilities or the increased use of existing fuel storage facilities;
- Use of new facilities and associated infrastructure (boilers, solvent degreasing, painting, used oil, spills, and incineration) or the increased use of existing facilities and associated infrastructure; and
- Use of earth-moving equipment during construction.

Emissions should be determined using EPA emissions factors and compared against ambient air quality standards. The emissions associated with industrial operations would be compared against historically similar operations or by methods outlined in the toxics release inventory, as necessary.

Launch Emissions

Emissions resulting from launch related activities would include CO, NO_X, PM, SO_X, VOC, and hydrogen chloride (HCl). The analysis of launch emissions impacts can be considered in two categories, above and below 914 meters (3,000 feet). The 914-meter (3,000-foot) altitude is an appropriate threshold because the EPA uses this altitude for determining contributions of emissions to ambient local and regional air quality. EPA emissions factors should be used to determine emissions fractions for each emission

source for emissions above and below 914 meters (3,000 feet). Total emissions should be estimated by multiplying emissions fractions by the total amount of propellant used.

Determination of Significance

For actions that would occur in the U.S. within a non-attainment or maintenance area, the total annual emission of each criteria pollutant would be calculated and would be compared against EPA *de minimis* levels. Annual emissions values that exceed the *de minimis* level or ten percent of the total emission budget of the non-attainment or maintenance area, or state or local ambient air quality standards would be considered significant and would require a general conformity evaluation.

The risk associated with the emissions of HAPs on sensitive receptors within the U.S. would be evaluated. (EPA, 1999) Risk factors that exceed acceptable levels established by EPA would be considered significant. Emissions within the U.S. would also be compared against the requirements and standards included in SIPs to address visibility at Class 1 areas (156 designated national parks, wilderness areas, and wildlife refuges). Emissions that exceed the regional haze standard of an SIP would be considered a significant impact. Actions proposed to occur outside of the U.S. and its territories would be reviewed in accordance with applicable international or foreign ambient air quality standards. Emissions that would occur in locations that violate applicable international or foreign laws would be considered significant.

The effects of emissions that would occur above an altitude of 914 meters (3,000 feet) would be reviewed for potential contribution to ozone depletion (particularly in the upper troposphere/stratosphere), acid rain, and global warming. To determine the significance of impacts to air quality, emission levels would be compared with studies of other similar emissions, as well as U.S. or global emissions of ozone-depleting substances, acids and greenhouse gases (e.g., CO_2). Annual emissions greater than one percent of the global emissions, annual MDA program emissions that exceed the average level of emissions associated with the program over the preceding three years by more than ten percent or single events that exceed one percent of the global emissions would be considered significant.

3.1.2 Airspace

Definition and Description

Airspace refers to the space that lies above a nation and comes under its jurisdiction. Airspace is a finite resource that can be defined vertically and horizontally, as well as temporally. Time is an important factor in airspace management and air traffic control. The FAA has established various airspace designations to protect aircraft while operating near and between airports and while operating in airspace identified for defense-related

purposes. Flight rules and air traffic control procedures govern safe operations in each type of designated airspace. Military operations follow specific procedures to maximize flight safety for both military and civil aircraft.

The types of airspace are defined by the complexity or density of aircraft movements, the nature of operations conducted within the airspace, the level of safety required, and the national and public interest in the airspace. The classes of airspace are controlled, uncontrolled, special use, and other airspace, as defined in Exhibit 3-4.

Exhibit 3-4. Definitions of Airspace Categories

Category	Definition	Examples
Controlled Airspace	Airspace used by aircraft operating under Instrument Flight Rules (IFR) that require different levels of air traffic service	Altitudes above Flight Level (FL) 180 (5,500 meters [18,000 feet] above MSL) Airport Traffic Areas Airport Terminal Control Areas Jet Routes Victor Routes
Uncontrolled Airspace	Airspace primarily used by general aviation aircraft operating under Visual Flight Rules (VFR)	As high as 4,420 meters (14,500 feet) above MSL
Special Use Airspace	Airspace within which specific activities must be confined or access limitations are placed on non-participating aircraft	Restricted Areas Military Operating Areas (MOA)
Other Airspace	Airspace not included under controlled, uncontrolled, or special use categories	Military Training Routes

Controlled Airspace

Controlled Airspace covers airspace used by aircraft operating under IFR that require different levels of air traffic service. As shown in Exhibit 3-4, examples of controlled airspace include the altitudes above FL 180 (approximately 5,500 meters (18,000 feet) above MSL, some Airport Traffic Areas, and Airport Terminal Control Areas. General controlled airspace includes the established Federal airways system, which consists of the high altitude (Jet Routes) system flown above FL 180, and the low altitude structure (Victor Routes) flown below FL 180.

Controlled airspace has numerous designations from Class A to Class G depending upon the degree of airspace control required to maintain flight safety. Airspace in North America contains "North American Coastal Routes," which are numerically coded routes

preplanned over existing airways and route systems to and from specific coastal fixes. North American Routes consist of

- **Common Route/Portion.** That segment of a North American Route between the inland navigation facility and the coastal fix.

- **Noncommon Route/Portion.** That segment of a North American Route between the inland navigation facility and a designated North American terminal.

- **Inland Navigation Facility.** A navigation aid on a North American Route at which the common route and/or the noncommon route begins or ends.

- **Coastal Fix.** A navigation aid or intersection where an aircraft transitions between the domestic route structure and the oceanic route structure.

During peak air travel times in the U.S., there are about 5,000 airplanes in the sky every hour. This translates to approximately 50,000 aircraft operating in U.S. skies each day. The U.S. airspace is divided into 21 zones (centers), and each zone is divided into sectors. Also within each zone are portions of airspace, about 81 kilometers (50 miles) in diameter, called Terminal Radar Approach Control airspaces. Multiple airports exist within each of these airspaces and each airport has its own airspace with an eight-kilometer (five-mile) radius.

Uncontrolled Airspace

Uncontrolled Airspace is primarily used by general aviation aircraft operating under VFR and generally refers to airspace not otherwise designated and operations below 365.8 meters (1,200 feet) above ground level. Uncontrolled airspace is not subject to the strict conditions of flight required by those aircraft using controlled airspace and can extend as high as 4,420 meters (14,500 feet) above MSL.

Special Use Airspace

Special Use Airspace is airspace within which specific activities must be confined or for other reasons, access limitations are imposed upon non-participating aircraft. The types of Special Use Airspace are

- **Alert Areas.** Alert areas are airspace in which a high volume of pilot training activities or unusual aerial activity takes place. The activities within alert areas are not considered hazardous to aircraft and are conducted in accordance with FAA regulations. Both participating and transiting aircraft are responsible for collision avoidance. (FAA, 2003)

- **Restricted Areas.** Restricted areas contain airspace identified by an area on the surface of the earth within which the flight of aircraft, while not wholly prohibited, is subject to restriction. Activities within these areas are confined to permitted activities and limitations are imposed upon all other aircraft operations. Restricted areas generally are used to contain hazardous military activities. The term "hazardous" implies, but is not limited to, weapons deployment (these areas also are referred to as controlled firing areas and may be either live or inert), aircraft testing, and other activities that would be inconsistent or dangerous with the presence of non-participating aircraft.

- **MOAs.** MOAs include airspace designated for non-hazardous military activities and are established outside of controlled airspace below FL180. Typical activities that occur in MOAs include military pilot training, aerobatics, and combat tactics training. When MOAs are in use, non-participating aircraft flying under IFR clearances are directed by air traffic control to avoid the MOA. However, even when a MOA is in use, entry into the area by VFR aircraft is not prohibited, and flight by non-participating aircraft can occur on a see-and-avoid basis.

- **Prohibited Areas.** Prohibited areas include airspace where no aircraft may be operated without the permission of the using agency. This airspace is established for security and other national welfare reasons. (FAA, 2003)

- **Warning Areas.** Warning areas include airspace that may contain hazards to non-participating aircraft in international airspace. Warning areas are established beyond the 22.2-kilometer (12-nautical-mile) limit. Although the activities conducted within warning areas may be as hazardous as those in restricted areas, warning areas cannot be legally designated as restricted areas because they are over international waters. (FAA, 1996) By Presidential Proclamation No. 5928, December 27, 1988 (issued in 1989), the U.S. territorial limit was extended from 5.6 to 22.2 kilometers (three to 12 nautical miles). Special Federal Aviation Regulation 53 establishes certain regulatory warning areas within the new (5.6- to 22.2-kilometer [three to 12-nautical-mile]) territorial airspace to allow continuation of military activities while further regulatory requirements are determined.

Other Airspace

Other Airspace includes Military Training Routes. They are low altitude, high-speed routes established by the FAA as airspace for special use by the military services. Routes may be established as IFR Routes or VFR Routes. Military Training Routes are depicted on aeronautical charts and detailed descriptions are provided in the DoD Flight Information Publication AP/1B.

En route airways and jet routes are air corridors used by commercial and private aircraft. These corridors are generated based on the prevailing jet stream and their positions vary. The airways are identified by a "V" and a number designation and apply to altitudes up to 5.5 kilometers (18,000 feet). Jet routes are identified by a "J" and a number designation and apply to altitudes over 5.5 kilometers (18,000 feet). Coordination procedures used at locations where activities for the proposed BMDS may occur would prevent any potential impacts to aircraft in these routes.

Impact Assessment

Assessment of potential impacts on airspace would include a review and analysis of

- Projected volume and frequency of flights into airspace areas;
- Operating altitudes of vehicles, missiles, and targets;
- Lateral orientation of aircraft, missiles, and targets;
- Identification of airspaces that would be entered;
- Anticipated effect of the use of sensors on airspace availability;
- Effects of intercept or booster failure debris on airspace areas;
- Identification and description of the Region of Influence;
- Necessary approvals or agreements with controlling and using agencies for special use airspaces; and
- Comparison of airspace used by aircraft operating under IFR versus VFR.

Using this information, a map of the Region of Influence would be developed for the affected areas, as well as charts detailing the airspace areas and potential conflicts or approval hurdles. Specific activities may require letters of agreement to operate in certain airspace. Impacts on airspace due to activities associated with the proposed BMDS would be identified at the programmatic level and mitigated to the extent possible. Site-specific impacts on airspace would be addressed in site-specific documentation.

Determination of Significance

Actions that conflict with existing airspace use or designations where approvals or agreements with regulatory agencies cannot be obtained would be considered significant.

3.1.3 Biological Resources

Definition and Description

Native or naturalized vegetation (flora), wildlife (fauna), and the habitats they occupy are collectively referred to as biological resources. As part of the NEPA analysis, the potential impacts to all species potentially impacted by the proposed activity are

considered and evaluated. Special emphasis is placed on those species that are designated as sensitive. Plant and wildlife species may be designated as sensitive because of overall rarity, endangerment, unique habitat requirements, and restricted distribution. Generally, a combination of these factors leads to a sensitivity designation. Sensitive plant and wildlife species include those listed or proposed to be listed as threatened or endangered by the USFWS and National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NOAA Fisheries Service) under the Endangered Species Act, as well as those species listed by state wildlife resource agencies.

Federally or state listed species are afforded regulatory protection that involves a permitting process, including specific mitigation measures for any allowable (incidental) impacts to the species. Species proposed to be listed are treated similarly to listed species, but recommendations of the USFWS are advisory rather than mandatory in the case of proposed species. A federally listed endangered species is defined as any species, including subspecies that is in “in danger of extinction throughout all or a significant portion of its range.” A federally listed threatened species is defined as any species “likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.” Proposed threatened or endangered species are those species for which a proposed regulation has been published in the FR, but a final rule has not been issued. In addition, the USFWS may designate critical habitat for threatened or endangered species. Critical habitat is defined as specific areas, within the geographical areas occupied by the species at the time it is listed, which contain the physical or biological features essential to conservation of the species and may require special management considerations or protection. In 2003, Congress amended the Endangered Species Act to allow the Secretary of the Interior to exempt DoD sites from critical habitat designations if adequate natural resources management plans are in place at the sites.

Federal agencies that propose to conduct activities that may impact a listed species or a species proposed to be listed are required to consult with the USFWS under Section 7 of the Endangered Species Act. Additional consultation activities with USFWS and other agencies with natural resource management responsibilities may be required under other applicable laws and regulations. A listing of relevant laws, regulations, and EOs is provided in Appendix G.

Impact Assessment

The impact analysis should include existing information on plant and animal species and habitat types in the vicinity of proposed sites, with special emphasis on the presence of any species listed as threatened or endangered by Federal or state agencies. In the U.S., proposed activities must be coordinated with the appropriate state wildlife agency to determine if threatened and endangered species or critical habitat exists within the region

of influence. If the proponent of the proposed activity determines that threatened or endangered species or critical habitat may be affected by the proposed action, the proponent would initiate either informal consultation or formal consultation under Section 7 of the Endangered Species Act. The consultation process may require the proponent of the proposed activity to conduct a biological assessment, resulting in a biological opinion from the resource agency. This opinion would include mitigation actions required of the proponent to ensure that impacts to species and habitat would be minimized.

If the proponent of the proposed action determines that marine mammals may be affected by the proposed action, the proponent should consult with NOAA Fisheries Service, Department of Interior, U. S. Fish and Wildlife Service, as appropriate, to ensure compliance with the Marine Mammal Protection Act. The Marine Mammal Protection Act established a moratorium, with certain exceptions, on the taking of marine mammals in U.S. waters and by U.S. citizens on the high seas, and on the importing of marine mammals and marine mammal products into the U.S. If the proponent of the proposed action determines that coral reefs or endangered fish habitat may be affected by the proposed action, the proponent should work with NOAA Fisheries Service to ensure all requirements are met.

If the proponent of the proposed activity determines that migratory bird species may be adversely impacted, then the proponent should consult with the USFWS's Regional Migratory Bird Program, to ensure compliance with the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act. Under the Migratory Bird Treaty Act, the taking of migratory birds is not authorized without a permit. The project proponent should also consult with the USFWS to determine whether conservation measures may be implemented to minimize or avoid the take of migratory birds. MDA has included a technical appendix, Appendix N, considering the potential effects of radar on migratory birds.

MDA activities that could contribute to biological impacts include air emissions and noise from missiles, EMR or radio frequencies from sensors or support assets, habitat destruction through clearing activities, and construction and operations, as well as debris impacts.

Activities Resulting in Air Emissions

Air emissions from transportation vehicles, dust from clearing or construction, or launch emissions such as the ground cloud from lift-off could impact biological resources. The potential for launch emissions to impact local wildlife, vegetation, and specialized habitat, such as wetlands, should be considered.

Activities Resulting in Noise

Noise produced from missile launches and other activities related to the BMDS could affect biological resources. The potential for this noise to affect areas used by wildlife for migration, foraging, and breeding, should be considered.

Activities Resulting in EMR or Radio Frequencies

Radars and other equipment could emit EMR or radio frequencies, with the potential to impact biological resources. The analysis of EMR and radio frequency emissions should include the following metrics for review of Institute of Electrical and Electronics Engineers (IEEE) and American National Standards Institute (ANSI) standards for exposure to EM fields

- Peak and average power (modulation properties),
- Polarization of the EM field,
- Power density values for the beams over the range and azimuth of the sensor,
- Typical motion of the beams, and
- Size of the main and side beams.

Construction and Operation Activities

The impacts analysis should address construction activities and operations that could result in impacts to habitat including loss and restriction of habitat; light pollution; and leaks, spills, and other releases of contaminants. Noise impacts from operation of generators and construction equipment have the potential to impact species in the area. Other noise including sonic booms from launch and flight of missiles also should be analyzed for potential impacts on biological resources.

Debris Related Activities

Debris from booster failures or missile intercepts could impact biological resources. Debris would fall in pre-established impact zones on land or in water. The expected casualty to humans from debris produced during launches would be less than or equal to 30×10^{-6}. Debris recovery efforts, if required, would only occur on land and could result in impacts to biological resources from transportation activities. Such disturbances could include noise, emissions, fire caused by debris or unspent fuel, chemical payloads (such as tributyl phosphate), and surface disturbance impacts.

Determination of Significance

Actions that negatively affect a species or its habitat (critical habitat or essential fish habitat) protected under Federal or state law or an international treaty (e.g., Endangered

Species Act, Marine Mammal Protection Act, Magnuson-Stevens Fishery Conservation and Management Act), as well as other resources provided protection under Federal or state regulations or orders (e.g., Sikes Act, Migratory Bird Treaty Act, EO 13112 Invasive Species), where appropriate consultation or considerations have not been completed, documented, and implemented would be considered significant. In addition, it may be appropriate to consider multiple species habitat conservation planning efforts occurring in areas proximate to proposed BMDS activities.

3.1.4 Cultural Resources

Definition and Description

Cultural resources include prehistoric and historic artifacts, archaeological sites (including underwater sites), historic buildings and structures, and traditional resources (such as Native American and Native Hawaiian religious sites). Paleontological resources are fossil remains of prehistoric plant and animal species and may include bones, shells, leaves, and pollen.

Cultural resources of particular concern include properties listed or eligible for inclusion in the National Register of Historic Places (National Register). Only those cultural resources determined to be potentially significant under 36 CFR 60.4 are subject to protection from adverse impacts resulting from an undertaking. To be considered significant, cultural resources must meet one or more of the criteria established by the National Park Service that would make that resource eligible for inclusion in the National Register. The term "eligible for inclusion in the National Register" includes all properties that meet the National Register listing criteria which are specified in Department of Interior regulations at 36 CFR 60.4. Therefore, sites not yet evaluated may be considered potentially eligible for the National Register and, as such, are afforded the same regulatory consideration as nominated properties. Whether prehistoric, historic, or traditional, significant cultural resources are referred to as historic properties.

Impact Assessment

Because they possess unique qualities and characteristics, cultural and historic resources should be identified and analyzed in site-specific environmental documentation. The analysis should include consideration of the contemporary use of historic properties owned by the Federal government and intergovernmental cooperation and partnerships for the preservation and use of historic properties as required by EO 13287, Preserving America. MDA activities that could impact cultural resources primarily include construction, operation, and debris impacts.

Construction and Operation Activities

The analysis should address construction and operation activities that could result in ground disturbances, vibrations, significant air emissions, or leaks, spills, and other accidental releases of contaminants. The proponent should identify the region of influence for the activities and contact the appropriate State Historic Preservation Officer to determine whether there are any known listed or eligible sites in the vicinity and to determine whether mitigation measures are required, such as: site-specific cultural and historic surveys, records searches of the sacred lands of the Native American Heritage Commission to determine the presence of Native American cultural resources in the region of influence, contacting Native American individuals and organizations for additional information, and using a qualified archaeologist to monitor site-specific ground-disturbing activities during construction. If appropriate, construction-related personnel would be informed of the sensitivity of cultural resources and the penalties that could be incurred if sites are damaged or destroyed. If during construction, cultural items are discovered, activities should cease in the immediate area and the corresponding State or Tribal Historic Preservation Officer would be notified. Subsequent actions should follow the guidance provided.

Debris Related Activities

Debris resulting from booster failures and missile intercepts could impact cultural resources. However, prior to establishing debris impact zones, archeological, cultural and historic surveys would be conducted to determine the presence of such resources. Debris recovery efforts, if required, would only occur on land, but should not impact cultural resources outside the impact zone. Efforts would be made to mitigate any impacts of transportation, noise, emissions and surface disturbance during recovery efforts.

Determination of Significance

Actions that would destroy or alter the character of a historic property on, or eligible for inclusion on the National Register, or actions that would adversely affect a Native American or traditional cultural property, where appropriate consultation in accordance with the National Historic Preservation Act has not been completed, would be considered significant. Such consultations and mitigation measures must be approved by the appropriate State Historic Preservation Officer, Tribal Historic Preservation Officer, or the ACHP.

3.1.5 Environmental Justice

Definition and Description

Environmental Justice (EO 12898) is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Fair treatment means that no group of people, including a racial, ethnic, or socioeconomic group, should bear a disproportionate share of the negative environmental consequences resulting from industrial, municipal, and commercial operations or the exclusion of Federal, state, local, and tribal programs and policies. Meaningful involvement means that potentially affected community residents have an appropriate opportunity to participate in decisions about a proposed activity that would affect their environment or health; the public's contribution can influence the regulatory agency's decision; the concerns of all participants involved would be considered in the decision-making process; and the decision-makers would seek out and facilitate the involvement of those potentially affected.

Environmental Justice concerns include consideration of the race, ethnicity, and the poverty status of populations near the site of a proposed action. The CEQ defined "minority" to consist of the following groups: Black/African American, Asian, Native Hawaiian or Other Pacific Islander, American Indian or Alaska Native, and Hispanic populations (regardless of race). The Interagency Federal Working Group on Environmental Justice guidance states that a "minority population" may be present in an area if the minority population percentage in the area of interest is "meaningfully greater" than the minority population in the general population. The CEQ defined "low-income populations" as those identified with the annual statistical poverty thresholds from the Bureau of the Census. The accepted rationale in determining what constitutes a low-income population is similar to minority populations, in that when the low-income population percentage within the area of interest is "meaningfully greater" than the low-income population in the general population, the community in question is considered to be low-income.

Impact Assessment

Although each community is unique, there are several determination procedures that are common to most environmental justice assessments. One must first identify whether the geographic area under consideration qualifies as low-income or minority-based. To identify minorities or low-income populations, the Environmental Index methodology in EPA Region 6, Office of Planning and Coordination, dated 1996 would be used. Based on that guidance, environmental justice populations can be defined as meeting either of the following criteria

- Over one-half of the residents are minorities; or
- Over one-half of the households are low income.

An analysis of the most recent census data for the area provides this information. The U.S. Census Bureau maintains census data for racial classifications and income levels. The five racial classifications for which data are maintained are white, black, Hispanic, American Indian/Eskimo/Aleut, and Asian/Pacific Islander. Low-income data relates to those households that fall below the mean poverty level. Using these data, the percentages of minority and low-income populations may be determined for a particular geographic area.

After determining whether a minority or low-income population exists in the area, a determination must be made as to whether the proposed action would have a disproportionately high or adverse effect on those populations. The analysis involves first determining whether there are significant and adverse impacts and second whether those impacts disproportionately affect the minority or low-income population in the area. Where environmental justice concerns are found, the EPA recommends increased public involvement, perhaps as early as project scoping. Public participation and access to information are emphasized in EO 12898 and the Presidential Memorandum. The Presidential Memorandum instructs agencies to provide opportunities for community input throughout the NEPA process, including identifying potential effects and mitigation measures in consultation with the community and improving access to meetings, documents, and notices.

Environmental justice analyses require information about local communities, and therefore will be analyzed in site-specific environmental documentation.

Determination of Significance

Adverse environmental impacts that disproportionately affect minority or low-income populations would be considered significant.

3.1.6 Geology and Soils

Definition and Description

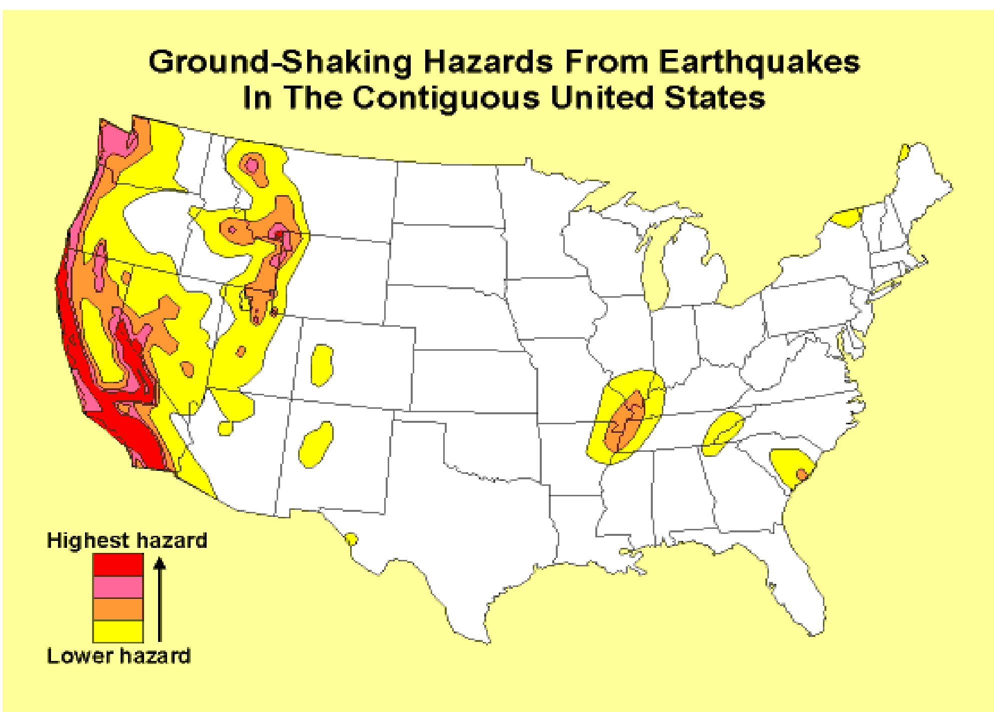
Geology and soils are those earth resources that may be described in terms of landforms, geology, and soil conditions. The makeup of geology and soils, including freshwater and marine sediments, could influence erosion, depletion of mineral or energy resources, seismic risk or landslide, structural design, and soil and ground water contamination resulting from proposed construction and operational activities.

Geology is the study of the composition and configuration of the Earth's surface and subsurface features. The general shape and arrangement of a land surface, including its height and the position of its natural and man-made features, is referred to as topography. The topography of the land surface can influence erosion rates and the general direction of surface water and ground water flow. Ground water is stored and transmitted underground in aquifers that supply lakes and rivers and is often used for human purposes, such as drinking water and irrigation for crops.

Geologic conditions also influence the potential for naturally occurring or human-induced hazards, which could pose risk to life or property. Such hazards could include phenomena such as landslides, flooding, ground subsidence, volcanic activity, faulting, earthquakes, and tsunamis (tidal waves). The potential for geologic hazards is described relative to each biome type's geologic setting. Exhibit 3-5 shows the geographic distribution for earthquakes in the continental U.S. Exhibit 3-6 shows landslide areas in the continental U.S.

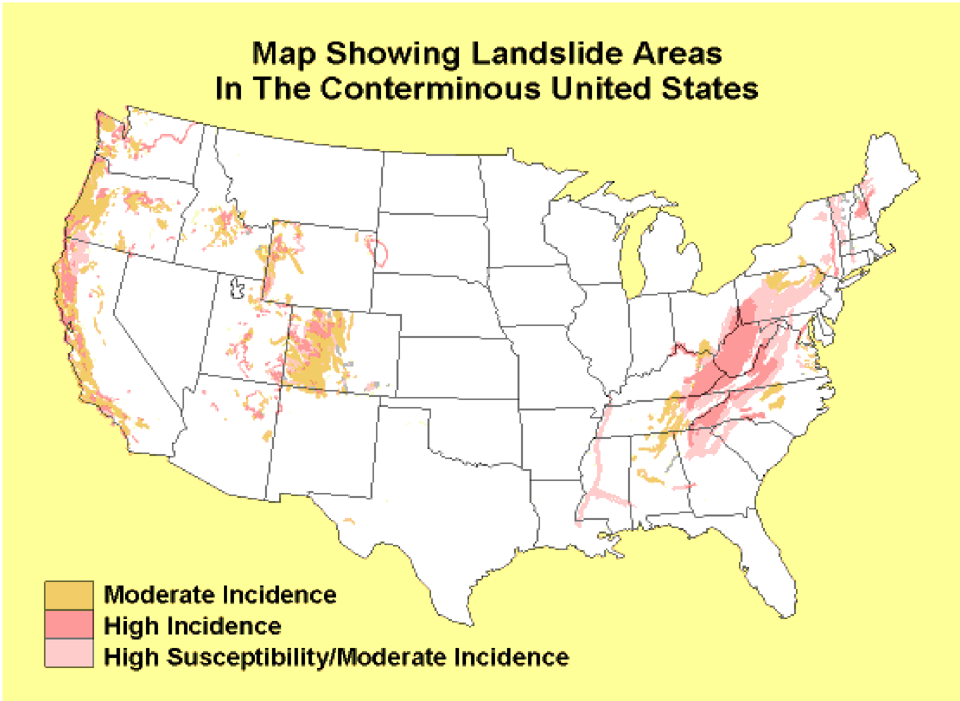
Soils and sediments are the unconsolidated materials overlying bedrock or other parent material. Soils and sediments typically are described in terms of their composition, slope, and physical characteristics. Differences among soil and sediment types in terms of their structure, elasticity, strength, shrink-swell potential, and erosion potential affect their

Exhibit 3-5. Geographic Distribution for Earthquakes in the Continental U.S.



Source: U.S. Geological Survey (USGS), 2002b

Exhibit 3-6. Landslide Areas in the Contiguous U.S.



Source: USGS, 2002d

abilities to support certain applications or uses. In appropriate cases, soil and sediment properties must be examined for their compatibility with particular construction activities or types of land use. In a limited number of cases, the presence, distribution, quantity, and quality of mineral resources might affect or be affected by a proposed action.

Impact Assessment

Site preparation activities such as grading, vegetation removal, and reseeding, as well as construction, operation, transportation and intercept debris could cause ground disturbances, and therefore could impact geology and soils. Ground disturbances should be assessed for potential impacts such as substantial erosion, siltation, landslides or slumps, soil compaction, or impacts to permafrost areas. In addition, ground disturbances could impact valuable mineral deposits or prime or unique farmland (see Section 3.1.9, Land Use). Off-road vehicle activities for debris recovery or other activities could impact soils as well. The potential for impacts depends upon the geology and topography of the area. Seismic activity within a region of influence should be evaluated and standard measures for seismic safety implemented. For example, construction activities should consider information bearing on seismic design and construction standards, and a design engineer and geotechnical consultant should consider surface faulting potential. Some test activities could impact the stability of seismically active areas. The handling of propellants and other chemicals, as well as launch impacts, should be assessed for potential spills or ground cloud effects of contaminating soils. Best Management

Practices should be identified in the impacts analysis. For example, frequent watering of excavated material and/or use of soil additives to bond exposed surface soils would reduce potential for soil erosion. The analysis also should evaluate the potential for debris craters in impact zones, including impacts to ocean sediment. For test activities, a qualified accident response team would be available near launch locations to minimize any adverse effects from an unlikely event such as flight termination.

Determination of Significance

Actions that would result in uncontrolled soil erosion, uncontrolled contamination of soil, disruption of more than one-acre of permafrost soil, or that would increase the geologic seismic instability of an area would be considered significant.

3.1.7 Hazardous Materials and Hazardous Waste

Definition and Description

Hazardous materials and hazardous waste are defined by a number of U.S. regulatory agencies. In general, hazardous materials and hazardous waste include substances that, because of their quantity, concentration, or physical, chemical, or infectious characteristics, may present substantial danger to the public health, welfare, or the environment when released. The EPA regulates hazardous chemicals, substances, and wastes under the Resource Conservation and Recovery Act (RCRA), the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), and the Toxic Substances Control Act. In addition, the Occupational Safety and Health Administration (OSHA) has definitions and workplace safety-related requirements and thresholds for listed "hazardous and toxic substances,"[37] and the U.S. DOT has definitions and requirements for the safe transport of "hazardous materials."[38]

Hazardous Materials Management

Hazardous materials management is the responsibility of the cognizant authority operating facilities, installations or ranges. Maintenance and flight support operations at various locations may require the use of products containing hazardous materials, including paints, solvents, oils, lubricants, acids, batteries, fuels, surface coatings, and cleaning compounds. These products would be used and stored at appropriate locations throughout each site, but would be primarily associated with industrial and maintenance activities. Site-specific plans would outline the strategies and procedures for storing, handling, and transporting hazardous materials, as well as responding to on-site or off-site spills.

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[37] OSHA, 2003
[38] DOT, 2003

Hazardous Waste Management

Federal and state regulations require that hazardous waste be handled, stored, transported, disposed of, or recycled in compliance with applicable regulations. Aircraft and vehicle maintenance, fuel storage and dispensing, and facility and grounds maintenance activities are MDA activity operations that could generate hazardous wastes. The sources of hazardous waste include waste fuel, chemical simulants, laser chemicals, waste oils, spent solvents, paint waste, and used batteries. Site-specific procedures and plans would outline the steps for appropriate management of hazardous wastes, such as satellite accumulation points and properly labeled DOT approved containers. Wastes may be disposed of using designated hazardous waste accumulation facilities or private hazardous waste contractors, as needed.

Impact Assessment

BMDS activities that could involve impacts from hazardous materials transport, disposal, storage, handling, and hazardous waste generation include site preparation and construction, prelaunch, launch/flight, and postlaunch activities and activation of laser weapons, sensors, and C2BMC. Site preparation activities could include exposure to previously contaminated sites. Missile build-out, fueling operations, or construction also may result in the handling of hazardous materials. The analysis should address the use of any ozone-depleting substances, such as refrigerants or foams.

Other toxic, corrosive, or flammable materials that personnel or environmental resources may be exposed to include asbestos, polychlorinated biphenyls, lead-based paint, radon gas, pesticides, petroleum and oils, chemical simulants, and propellants.

Any hazardous waste generated would be disposed of per appropriate state and Federal regulations. Federal military ranges would have established instructions to ensure proper handling and use of hazardous materials. Personnel involved in such operations would be trained in the appropriate procedures to handle hazardous materials and would wear protective clothing and receive specialized training in spill containment and cleanup. Any spills would be handled using established cleanup procedures. All tasks would be performed in accordance with standard operating procedures, and would include provisions for proper handling of hazardous materials/wastes and waste minimization.

Determination of Significance

Actions that would result in uncontrolled generation of hazardous materials or waste, actions that would require hazardous materials and do not have a closure or decommissioning plan, actions that would conflict with existing RCRA or other hazardous material or waste regulations, or actions that would expose the general public, unprotected MDA personnel, or wildlife to hazardous materials or waste that would result

in human or ecological health risk levels greater than 1 x 10^{-6} would be considered significant.

3.1.8 Health and Safety

Definition and Description

Health and safety includes consideration of any activities, occurrences, or operations that have the potential to affect the well being, safety, or health of workers or members of the general public. The primary goal is to identify and prevent accidents or impacts to on-site workers and the general public. In terms of the proposed action and alternatives, safety and health risks would occur primarily from accidents during construction, testing, operation, maintenance, or decommissioning activities. Safety and health risks may also occur from exposure to debris produced during test activities. The health and safety resource area addresses both occupational and environmental health and safety.

Occupational Health and Safety

Occupational health and safety deals with work sites and operational areas where workers would be located. (DOT, 2002) Typical potential hazards and accidents include

- Explosions of flammable liquids, solids, or compressed gases;
- Fires;
- Failures leading to fires or explosions involving boosters or other launch assets;
- Electrocution and burns from electrical equipment and currents;
- EM emissions (radars, lasers, infrared sensing devices);
- Inhalation or dermal exposure to hazardous materials or waste;
- Spills of chemicals and propellants;
- Falling debris related to construction and decommissioning;
- Confined spaces;
- Falls from structures;
- Accidents related to earth moving equipment and power tools; and
- Transportation accidents.

Hazard analyses are performed to identify and assess credible accident scenarios at work sites. The findings of a hazard analysis are used to establish health and safety procedures to prevent accident occurrences and to report and respond to any accidents that do occur.

Environmental Health and Safety

Environmental health and safety considers environmental quality both on and off the work site and operational areas that could impact the human health of the general public. Typical potential hazards and accidents include

- Explosions of flammable liquids, solids, or compressed gases;
- Fires;
- EM emissions (radars, lasers, infrared sensing devices);
- Spills of chemicals or propellants that contaminate surface or ground water;
- Inhalation of hazardous particulate and gaseous materials;
- Chronic/acute exposures to toxic/hazardous materials;
- Failures of electrical grids;
- Falling debris (e.g., from interceptor tests);
- Transportation accidents; and
- Personnel injury and equipment damage due to electrical shock.

Risk assessments are performed to identify, characterize, quantify, and evaluate risks to human health and the environment. A risk assessment considers both the likelihood or probability of occurrence and the consequences of accidents and hazardous events, including catastrophic ones. The results of a risk assessment are used to establish preventative and mitigating measures to reduce the risks to environmental quality and human health. Consideration of risk would also include debris modeling and analysis to determine the potential impact area in the event of a launch failure (including those launches requiring use of an FTS).

Impact Assessment

MDA activities with the potential to impact the health and safety of workers include construction; radar activation, laser weapon activation, missile storage, assembly, and transfer; and launch and post-launch activities. Any debris recovery and emergency operations also could impact worker health and safety. The areas of potential impacts to the health and safety of the public include prelaunch transport of missiles, launches, radar activation, laser activation, and missile flight. The potential impacts of a launch failure should be analyzed. Launch failure could involve an explosion, falling missile debris, release of toxic materials into the air or water, high noise levels, and/or fire.

Handling and assembly of missile components, which are typically accomplished within enclosed buildings, have the potential to affect worker health and safety. Range Commanders Council Standard 321-02 limits the collective risks to 1×10^{-3} for non-mission essential personnel and to 1×10^{-2} for mission essential personnel. If a launch site malfunction occurs, it could result in the scattering of the resulting missile debris anywhere within the LHA. A probabilistic risk analysis would be performed before each flight test to determine that individuals of the general public would not be exposed to a probability of fatality greater than 1 in 10 million for any single mission and 1 in 1 million on an annual basis, as per the Range Commander's Council Standard 321-02. Site-specific environmental documents would identify and, if appropriate, analyze required health and safety regulations for individual sites where activities for the

proposed BMDS may occur. Compliance with Federal, state and local regulations would be required.

Federal military ranges would have specific regulations to ensure the health and safety of members of the range as well as the public in the surrounding area. Applicable safety regulations would be followed in the transport, receipt, storage, and handling of hazardous materials. All shipping would be conducted under DOT regulations. Transportation and loading practices would meet Federal, state, and local regulatory and safety requirements.

Determination of Significance

Actions that would not fall under the existing health and safety operating procedures of the facility or range where such actions would occur, actions that would conflict with existing OSHA regulations, or actions that would result in a level of risk that exceeds the Range Commanders Council Standard 321-02 to the health and safety of the general public and MDA personnel would be considered significant.

3.1.9 Land Use

Definition and Description

Land use is described as the human use of land resources for various purposes, including economic production, natural resource protection, or institutional uses. Land uses frequently are controlled by management plans, policies, ordinances, and regulations that determine the uses that are permissible or protect specially designated or environmentally sensitive areas (e.g., prime farmlands, coastal zones, national parks, historic properties). Planning departments at the local and municipal level typically designate land uses for specific areas, which describe the permitted development activities that are acceptable for the area, such as agricultural, residential, commercial, and industrial.

Public land may be assigned specific designations for which land use and management guidelines are provided. These designations include

- Controlled use or wilderness areas;
- Limited use areas, which protect sensitive, natural, ecological, scenic, and cultural resource values;
- Low intensity regions, which carefully control multiple uses of resources and ensure sensitive values are not significantly diminished;
- Moderate use regions, which provide for a controlled balance between higher intensity uses and resource protection; and
- Intensive use regions, which provide for concentrated use of lands and resources to meet human needs.

Types of land use include agriculture, livestock grazing and production, conservation and recreation sites, military installations, and research sites managed by other agencies and organizations. A particular environment may include cities, towns, and rural communities of all sizes, throughout which are extensive communication systems; industrial complexes with factories and power plants; energy distribution systems for electricity, natural gas, liquid fuels, and nuclear, solar, hydro, and wind power; water treatment facilities; and waste management facilities. Wildlife refuges, national landmarks, and coastal zones present within an environment typically are afforded special status or protection.

A given site for proposed BMDS activities may include launch sites, impact areas, instrumentation sites, facilities, and equipment. On-site land use designations may include flight line zones, test ranges, support service areas, and explosive hazard zones. Land use categories for each site may be defined independently. Differences in terminology for land use classification among facilities where activities for the proposed BMDS may occur can be attributed to the local nature of land use classification, the unique circumstances at a particular facility, or the different interpretations of widely used terms (e.g., industrial, open space). Each land use category depends on a variety of factors, including the level of residual hazards and the risks associated with potential exposures.

The combined efforts of state, county, local, and on-site plans may regulate land use within the boundaries of a particular installation. Facilities where proposed BMDS activities may occur may use a wide range of planning documents as their land use plans, including legal settlement agreements narrowly tailored to designating land uses; comprehensive site plans incorporating all planning information, including current and future land uses, budget projections, and institutional plans; and a hierarchy of multiple planning documents. Wide variation in the level and types of coordination between site personnel and off-site communities regarding land use planning issues may occur. The variation appears to depend on the site's mission, closure schedule, proximity to local off-site development, and level of community interest. On-site land use management plans may address the security of essential mission activities from encroachment and the protection of both human and natural environments.

Impact Assessment

Numerous land use designations may characterize a given environment and the sites located within that environment. As a result, site-specific analysis will identify and, if appropriate, analyze potential impacts to particular land use designations for individual sites where activities for the proposed BMDS may occur. Compliance with Federal and state regulations and local land use plans would be required. Site-specific analysis would be coordinated with the appropriate agencies, including the Bureau of Land Management, National Park Service, U.S. Department of Agriculture Forest Service, and state agencies,

as well as county and municipal planning groups and local communities. At some facilities, it may be necessary to address the issue of encroachment to ensure that off-site development is not encroaching on the site where activities for the proposed BMDS may occur.

Determination of Significance

Actions that would require modification to an existing land use plan of an installation or range, or would preclude existing land use activities at lands adjacent to the action that are not owned by DoD or for which no easement exists between the land owner and the DoD for longer than one week, actions that would disrupt or divide established land use configurations or represent a substantial change in existing land uses, actions that would require the use of other Federal lands where an existing use agreement has not been prepared and authorized by both Federal Agencies, or conflict with existing regulations and policies governing land use (e.g., Coastal Zone Management Act) would be considered significant.

3.1.10 Noise

Definition and Description

Noise is often defined as unwanted or annoying sound that is typically associated with human activity. Most sound is not a single frequency, but rather a mixture of frequencies, with each frequency differing in sound level. The intensities of each frequency combine to generate sound, which usually is measured and expressed in decibels (dB). Decibels are measured on a logarithmic scale, which means that a doubling of sound energy or number of sources producing the same sound level will result in a three dB increase. A 3 dB increase is considered just noticeable to most people, while a 10 dB increase is considered a doubling of perceived loudness.

- **A-weighted decibels (dBA)**. Most measures of noise for community planning purposes use dBA, which are used to characterize noise as heard by the human ear.

- **Community Noise Equivalent Level**. The Community Noise Equivalent Level describes the average sound level during a 24-hour day in dBA. For noises occurring between 7:00 p.m. and 10:00 p.m., five dBA are added to the measured noise level, and for noises occurring between 10:00 p.m. and 7:00 a.m., 10 dBA are added to the measured noise level.

- **Day night average noise level (DNL)**. DNL is the energy average noise level during a 24-hour day. It is reported in dBA and is used to predict human annoyance and community reaction to unwanted sound (noise). Because humans are typically more

sensitive to noise in the evening, the DNL places a 10-dBA penalty on noise produced between the hours of 10:00 p.m. and 7:00 a.m.

- **Equivalent Noise Level (L_{eq})**. The L_{eq} is the energy average A-weighted sound level during a stated measurement period. It is used to describe the time-varying character of environmental noise.

- **Pounds per Square Foot**. Pounds per square foot is a measure of pressure. Some activities of the proposed BMDS may produce pressure waves in the form of sonic booms that can cause damage to eardrums and structures.

Examples of A-weighted noise levels for various common noise sources are shown in Exhibit 3-7.

Exhibit 3-7. Comparative A-Weighted Sound Levels

Noise Level (dBA)	Common Noise Levels	
	Indoor	**Outdoor**
100 – 110	Rock band	Jet flyover at 304 meters (997 feet)
90 – 100	Food blender at one meter (three feet)	Gas lawnmower at one meter (three feet)
80 – 90	Garbage disposal at one meter (three feet)	Diesel truck at 15 meters (49 feet) - Noisy urban daytime
70 – 80	Shouting at one meter (three feet) Vacuum cleaner at three meters (ten feet)	Gas lawnmower at 30 meters (98 feet)
60 – 70	Normal speech at one meter (three feet)	Commercial area heavy traffic at 100 meters (328 feet)
50 – 60	Large business office Dishwasher next room	
40 – 50	Small theater (background) Large conference room (background)	Quiet urban nighttime
30 – 40	Library (background)	Quiet suburban nighttime
20 – 30	Bedroom at night	Quiet rural nighttime
10 – 20	Broadcast/recording studio (background)	
0 – 10	Threshold of hearing	

Source: Modified from FAA, 2001

Noise from transportation sources, such as vehicles and aircraft, and from continuous sources, such as generators, would be assessed using the A-weighted DNL. The A-

weighted DNL significantly reduces the measured pressure level for low-frequency sounds, while slightly increasing the measured pressure level for some high-frequency sounds. Noise from small arms ranges is assessed using the A-weighted DNL. Impulse noise resulting from armor, artillery, and demolition activities is assessed in terms of the C-weighted DNL. The C-weighted DNL is often used to characterize high-energy blast noise and other low frequency sounds capable of inducing vibrations in buildings or other structures. The C-weighted scale does not significantly reduce the measured pressure level for low frequency components of a sound.

Impact Assessment

The acceptability of noise depends in part on expectations associated with land use. An urban environment is noisier than a suburban environment, and a suburban environment is noisier than a rural one. Exhibit 3-8 provides a range of DNL values by land use type.

Exhibit 3-8. Examples of Outdoor Day-Night Average Noise Levels in Various Land Use Locations

Outdoor Location	DNL in dB
Apartment next to freeway	88
¾ mile from touchdown at major airport	86
Downtown with some construction activity	79
Urban high density apartment	78
Urban row housing on major avenue	68
Old urban residential area	59
Wooded residential	51
Agricultural crop land	44
Rural residential	39
Wilderness ambient	35

Source: EPA, 1978

Exhibit 3-9 lists noise measurements that were recorded at some existing facilities where launch activities have taken place, which encompass various environmental settings.

Site-specific analysis would identify and, if appropriate, analyze potential impacts from noise levels at individual sites where activities for the proposed BMDS may occur. Noise impacts resulting from activities associated with the proposed BMDS may include but are not limited to construction activities, missile launches, and use of generators. Three types of receptors are typically analyzed: humans, wildlife, and structures. For each type of receptor, the potential impacts of noise would need to be analyzed in site-specific analyses.

Exhibit 3-9. Range of Noise Measurements

Measurement Locations		Noise Level (dBA)
Remote desert environments[39]		22-38
Interstate interchanges (non-urban)[40]		55-70
Marshall Space Flight Center (wooded area with insects dominating the higher reading)[41]		40-54
Vandenberg AFB[42]		48-67
Edwards AFB (with some areas off base at 80 dBA)[43]		65-85
WSMR[44]	Main post	55-65
	Property boundary	45-55
	Nearby San Andreas National Wildlife Refuge	45
Eastern Range[45]		60-80
KLC[46]	Approximately 1,905 meters (6,250 feet) from center of pad	95
	Distance of 9 to 24 kilometers (5.6 to 15 miles) from the launch pad	70

Source: Modified from DOT, 2001b

Launch Activity Noise

Noise during launch activities would occur due to the rocket engine. Noise generated during launch would result from the interaction of the exhaust jet with the atmosphere and the combustion of the fuel. The sound pressure from a missile is related to the engine's thrust level and other design features. Workers exposed to excessive launch noise would be required to wear hearing protection.

Sonic booms also would be generated during launches when the launch vehicle reached supersonic speed. A sonic boom is a sound that resembles rolling thunder, and is produced by a shock wave that forms at the nose of a vehicle that is traveling faster than

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[39] Estimate, no other specifics given
[40] Monitoring data, no other specifics given
[41] One-hour monitoring
[42] Twenty-four hour monitoring
[43] Monitoring data, no other specifics given
[44] Estimate, no other specifics given
[45] Daytime monitoring
[46] Rocket noise levels from launch of U.S. Air Force atmospheric interceptor technology test vehicles

the speed of sound. The sound heard at the Earth's surface as the "sonic boom" is the sudden onset and release of pressure after the buildup by the shock wave or "peak overpressure."

Construction Noise

In addition to operational noise, construction would result in intermittent, short-term noise effects that would be temporary, lasting for the duration of the noise generating construction activities. Noise-generating construction activities would include excavation and grading, utility construction and paving, and frame building. The specific types of equipment that would be used during construction would be identified in site-specific analyses. Excavation and grading would normally involve the use of bulldozers, scrapers, backhoes, and trucks. The construction of buildings likely would involve the use of pile drivers, concrete mixers, pumps, saws, hammers, cranes, and forklifts.

Power Generation Noise

The use of power generators should not exceed locally regulated noise levels or facility specific noise levels. The noise associated with generators would be controlled by use of standard silencing packages (mufflers) provided by the manufacturer and routine maintenance and inspection of such systems.

<u>Human Response</u>. Noise from single events can be annoying due to noise level, duration of the event, how loud the event is relative to ambient sound levels, and the frequency of occurrence. Additional annoyance can be attributable to a 'startle effect' associated with a sonic boom. Site-specific analysis will identify and, if appropriate, analyze potential impacts from noise levels at individual sites where activities for the proposed BMDS may occur. Compliance with Federal as well as state and local regulations will be required. (EPA, 1978, as referenced in DOT, 2001b)

The annoyance experienced as a result of sonic booms has been widely studied both in the field and in laboratory settings. Annoyance is generally considered to be a function of boom intensity, number of booms per time period, attitude of the population, and the activity in which people were engaged in at the time of the boom. However, there is no precise relationship between the parameters. One study was done to determine the reactions of people routinely exposed to sonic booms (eight sonic booms per day) over a six-month period. This study found that sonic boom annoyance increases as the number and or level of sonic booms increases. (DOT, 2001b) In that study, approximately 20 percent of the population reported annoyance from sonic booms with median peak overpressures of 0.5 psf. Another study suggested that prior experience with sonic booms (such as people who live on an AFB) seems to lower sensitivity to sonic booms. (DOT, 2001b) Other factors that influence the loudness and annoyance are the rise time of the sonic boom and shape of the waveform. (DOT, 2001b) In general, some public

reaction can be expected if occasional sonic booms with peak overpressures between 1.5 and 2 psf impact populated areas (NASA, 1994), but it is possible that at lower amplitudes people can express annoyance to sonic booms. The impacts assessment would include the number, frequency, location, and intensity of sonic booms, and identify affected receptors.

Structural Response. Sonic booms also may cause structural damage, which could impact prehistoric and historic resources. Vibrations from the sonic booms could disturb existing cultural and historic structures, especially those that are not structurally sound. The impacts assessment would identify and evaluate effects on existing cultural resources and historic structures.

Wildlife Response. Responses of wildlife would vary based on the type of noise and its characteristics (amplitude, rise time, duration, frequency content), the species of wildlife, hearing capability, location, habitat type, current activity of the animal, sex and age, previous experience with noise exposure, and condition of the animal. (Manci, 1988) Potential physiological impacts from noise can range from short-term mild impacts, such as an increase in heart rate or small temporary changes in hearing, to more damaging impacts, such as permanent changes in hearing, metabolism, and hormone balance, to long-term severe impacts, such as chronic distress that is harmful to the health of wildlife species and their reproductive fitness. (DOT, 2001b) Potential behavioral impacts from noise also range greatly from minor responses, including small changes in current behavior such as, a "heads up" response, to more severe responses, such as panic and escape flight responses that might result in physiological damage (falling, trampling, crashing, piling). Behavioral responses of wildlife to noise also can accompany physiological responses. The impacts assessment would identify and evaluate effects on affected wildlife, including threatened and endangered species and migratory populations.

Hearing Damage

The OSHA regulation 1910.95 establishes a maximum noise level of 90 dBA for a continuous eight-hour exposure during a working day and higher levels for shorter exposure time in the workplace. The OSHA standards allow for a 5 dBA increase in sound level for a 50 percent reduction in exposure time. Therefore, the maximum noise exposure permitted under the regulation for continuous exposure would be 115 dBA for 15 minutes. (FAA, Aviation Noise Effects, 1985) Other standards have also been recommended for exposure to continuous noise. The EPA has recommended an average L_{eq} of 70 dBA for continuous 24-hour exposure to noise to protect hearing. This level is considered conservative and is based on the probability of negligible hearing loss, defined as less than 5 dB in 100 percent of the exposed population, at the human ear's most sensitive frequency (4,000 hertz) after a 40-year exposure. (FAA, 1985) Noise also

may be impulsive in nature. Under OSHA regulation 1910.95 exposure to impulse noise should not exceed 140 dBA.

Determination of Significance

Federal and state agencies that regulate noise handle the determination of significant noise impact differently. For example, the FAA considers the threshold of a significant impact to be a 1.5 dBA increase from 65 DNL (FAA Order 1050.1E) Federal Highway Administration (FHWA) does not employ significance thresholds for noise; rather, FHWA uses Noise Abatement Criteria (NAC) where noise abatement is considered (where reasonable and feasible) for EISs as well as EAs. The NAC vary by land use—the residential NAC is 66 dBA, 1 hour L_{eq}. FHWA considers both absolute and relative noise impacts. A relative noise impact refers to the amount of project-related noise increase above ambient noise levels.

Potential BMDS noise impacts could be associated with a wide range of noise sources and noise environments. For example, a generator produces a steady-state noise, with moderate noise levels and limited geographic effect. A missile launch could produce high noise levels for a short duration with little to no exposure in populated areas. Because NEPA requires ‘context and intensity’ in consideration of significant impact, these disparate noise situations potentially call for different definitions of significance. Therefore, the details of what would comprise a ‘significant’ noise impact for the PEIS will be developed and considered on a case-by-case basis.

3.1.11 Socioeconomics

Definition and Description

Socioeconomics is defined as the basic attributes and resources associated with the human environment, in particular population and economic activity. Socioeconomic resources consist of several primary elements including population, employment, and income. Other socioeconomic aspects that are described often may include housing and employment characteristics, and an overview of the local economy.

Impact Assessment

Potential socioeconomic impacts from MDA activities may stem from construction or operation of the BMDS. The magnitude of the impacts would depend on the duration and extent of displacement or modification of existing activities and the diversion or temporary suspension of access. Impact analyses should focus on the following broad areas of economic or social impacts: employment and income; growth inducement; potential impacts to locally significant industries such as tourism, commercial fishing, or

agriculture; displacement of populations, residences, or businesses; and housing or accommodation availability.

Employment and Income

Activities for the proposed BMDS could have a positive economic impact in local communities due to increased jobs in the defense industry. These jobs generally are technology-based and require workers with specialized skills and education. These jobs would contribute to local economies by increasing personal income, thereby increasing the tax base. In addition, an increase in workers in a particular area increases the need for services, which creates more jobs in other industries, such as retail, food services, education, and health.

Local Economies

Additional construction personnel, by spending money in the local economy, mainly via accommodation and procurement of goods and services, would represent both a potential increase in local service-based employment opportunities and a small but positive temporary economic impact to the local community. Site-specific documentation would be required for comprehensive analysis of impacts to local economies.

Displacement Impacts

Some missile defense activities could result in a negative economic impact from displacement of populations, residences or businesses; housing or accommodation availability. For example, health care facilities, housing, and other infrastructure may be insufficient in some areas to support an influx of workers during construction. Testing and operation activities also may require an influx of additional personnel into the area. Proposed activities also could cause displacement of populations during test events and potential impacts to local industries such as tourism, or agriculture due to the closure of these areas during test events. Proposed activities could cause a loss in property value due to adjacent test activities. Site-specific analyses would be required to determine the magnitude of the potential for impact.

Determination of Significance

Significant economic or social impacts do not require preparation of an EIS unless those impacts are combined with significant impacts from other resource categories (see 40 CFR 1504.14). Actions that would disrupt local or regional economies or would displace or introduce a new population that would substantially alter the socioeconomic setting, or actions that would cause a ten percent increase in the risk of crime or other undesirable social factors would be considered significant.

3.1.12 Transportation

Definition and Description

The transportation section addresses ground, air, and marine transport systems.

According to the most recently available data, the U.S. has over four million miles of highways, railroads, and waterways that connect all parts of the country. It also has 19,000 public and private airports and approximately 1.6 trillion miles of oil and gas distribution pipelines. This extensive transportation network supported about 4.9 trillion passenger-miles of travel in 2001 and 3.8 trillion ton-miles of commercial freight shipments in 2001. The U.S. transportation system, one of the world's largest, serves 284 million residents and seven million business establishments. (DOT Bureau of Transportation Statistics [BTS], 2003)

Metropolitan areas are characterized by urban transit, a complex mix of heavy, light, and commuter rail; buses and demand responsive vehicles; ferries; and other less prevalent types such as inclined planes, trolley buses, and automated guide ways. More than one-third of America's population lives outside of urbanized areas, which typically do not have extensive transit systems.

Paved roadways constituted about 65 percent of all highway mileage in 2001. Nearly all of the public roads in U.S. urban areas are paved, however, about half of the miles of rural public roads are unpaved. In 2001, 71 percent of U.S. roads were classified as being in good or very good condition and 14 percent as mediocre or poor. The remaining 15 percent were classified as fair. The generally poorer condition of urban roads, as compared with rural roads, can be attributed to the higher levels of traffic they carry. (DOT BTS, 2003) Urban roads handled about 60 percent of all traffic in 2000 with far fewer miles of road. (DOT BTS, 2001)

The most heavily populated states, California, Texas, Florida, and New York, are the most heavily traveled. However, Wyoming, the least populated state, had the highest vehicle-miles of travel per capita in 2000 at 16,400, followed by Georgia, Alabama, Oklahoma, and New Mexico at over 12,500. The District of Columbia and New York had the lowest vehicle-miles of travel per capita at less than 7,000. (DOT BTS, 2001) Landside access to water ports comprises a system of intermodal rail and truck services. Landside congestion, caused by inadequate control of truck traffic into and out of port terminals combined with the lack of adequate on-dock or near-dock rail access, affects the productivity of U.S. ports and the flow of U.S. international trade. Changes in vessel design impact access to both landside and waterside services. For example, container vessels have increased in size and capacity, which, in turn, drives a need for adequate trans-shipment hub and feeder ports.

Ground Transportation

Ground transportation and traffic circulation refer to the movement of vehicles from origins to destinations through a road and rail network. Roadway operating conditions and the adequacy of the existing and future roadway system to accommodate these vehicular movements usually are described in terms of the volume-to-capacity ratio, which is a comparison of the average daily traffic volume on the roadway to the roadway capacity. The volume-to-capacity ratio corresponds to a Level of Service (LOS) rating, ranging from free-flowing traffic conditions (LOS A) for a volume-to-capacity of usually less than 30 percent of the roadway capacity to forced-flow, congested conditions (LOS F) for a volume-to-capacity of 100 percent of the roadway capacity. LOS A, B, and C are considered good operating conditions where motorists experience minor delays. LOS D represents below average conditions, and LOS E corresponds to the maximum capacity of the roadway. LOS F indicates a congested roadway.

Railway operating conditions and safety standards in the U.S. are regulated by the U.S. DOT, Federal Railroad Administration. The Federal Railroad Administration has established standards for nine types of track (Class 1 through 9); each class has unique construction, maintenance, and inspection standards, as well as operational requirements. Class 1 track is the minimum acceptable standard for general use and has a 16 kilometer per hour (ten mile per hour) speed limit for freight and a 24 kilometer per hour (15 mile per hour) speed limit for passengers. Class 9 track has the most stringent track standards and allows both freight and passenger trains to travel up to 322 kilometers per hour (200 miles per hour). Local regulations, e.g., city speed limits, may reduce speeds regardless of track quality. (DOT, FRA 2002)

Air Transportation

Air transportation refers to the movement of aircraft through airspace. The control of airspace used by air traffic varies from very highly controlled to uncontrolled areas. Examples of highly controlled air traffic situations are flight in the vicinity of airports, where aircraft are in critical phases of flight (take-off and landing), flight under IFR, and flight on the high or low altitude route structure (airways). Less controlled situations include flight VFR or flight outside of U.S. controlled airspace (e.g., flight over international waters off the coast of California, Hawaii, or Alaska).

Marine Transportation

Marine traffic is the transportation of commercial, private, or military vessels at sea, including submarines. Marine traffic flow in congested waters, especially near coastlines, is controlled by the use of directional shipping lanes for large vessels (cargo, container ships, and tankers). Traffic flow controls also are implemented to ensure that harbors and ports-of-entry do not become congested. There is less control on ocean

traffic involving recreational boating, sport fishing, commercial fishing, and activity by naval vessels. However, U.S. Navy vessels follow military procedures and orders (e.g., Fleet Forces Command) as well as Federal, state, and local marine regulations. In most cases, the factors that govern shipping or boating traffic include adequate depth of water, weather conditions (primarily affecting recreational vessels), the availability of fish of recreational or commercial value, and water temperature (higher water temperatures will increase recreational boat traffic and diving activities).

Impact Assessment

General transportation impacts can be assessed by determining the existing traffic flow and LOS. MDA activities that could cause impacts to the LOS include the increased delivery of construction equipment, propellants, or test event equipment, and the influx of construction workers or test operation personnel. In addition, roads, ports, or waterways within the LHA may be closed during test events. Roads also may be closed during the arrival of missile payloads and/or boosters to ensure that roadways near a Range would be vacated.

The region of influence in determining impacts would depend on local traffic volume and transportation infrastructure. At the programmatic level, analysis shows that construction events and associated increases in transport of equipment and personnel are typically short-lived. However, site-specific analyses should be completed to determine local conditions.

Determination of Significance

Actions that are not included as categorical exclusions in DoD's NEPA implementing regulations, or actions that would require the movement of an extremely hazardous, toxic or radiological substance, would generate traffic levels that would require construction of new roadways or expansion of existing roadways, alteration of circulation patterns, or would result in inadequate parking, transportation actions that would result in multi-day disruptions (more than two days) of marine or air traffic shipping lanes would be considered significant. In addition, actions that would result in road closures for more than two days or closures of major highways for more than one hour during peak traffic hours would be considered significant.

3.1.13 Utilities

Definition and Description

The purpose of the utilities section is to address the existing rate of consumption, generation, and distribution of utilities, which include energy, water, wastewater, and solid waste and construction debris. This section address those facilities and systems that

provide power, water, wastewater treatment, the collection and disposal of solid waste, and other utility services.

- **Energy**. Energy refers to the power that is produced by a central electrical power plant or, in some cases, by individual power generators. The power would be utilized for both construction and operational activities on different sites.

- **Water**. Water refers to the system that produces water, the treatment system that purifies the water, and the network that distributes that water. This water system usually is controlled, managed, and distributed by an entity such as a utility purveyor. In the absence of a water system, individualized water wells or a series of wells meet the demand for water. The water system is identified by potable, or drinkable, freshwater and nonpotable water used for other activities such as construction, operations, and irrigation. In some cases the non-potable system is saltwater. The water system is composed of a source that produces the water and the treatment systems that cleanse and purify it, making it available for use. Water made available to the public must meet EPA standards as described in Section 3.1.15.

- **Wastewater**. There are different methods of treating wastewater that is produced by a site. Wastewater can be collected in a central system and then directed to a treatment plant where it can be treated and then discharged. In many instances, the wastewater is further treated and reclaimed for use as nonpotable water. In the absence of a central system, septic systems collect and treat water either individually (individual households) or collectively (within a community).

- **Solid Waste**. Solid waste disposal includes the collection, handling, and disposal of waste. Designated landfills within an area or region are the final destinations where solid waste and construction debris is transported for processing. Solid waste usually is processed to separate out recyclable products first. Solid waste disposal also includes practices such as open burning, septage disposal, and burial in open or excavated trenches, where allowed by law.

Impact Assessment

A site-specific impact assessment should consider whether there is adequate wastewater treatment capacity or capability and if the proposed action would exceed wastewater treatment requirements and alter the existing rate of consumption, generation, and distribution of utilities. An impact analysis should include an evaluation of waste disposal facilities and landfills and waste discharge requirements. MDA activities require consistent power sources, and depletion of an existing power supply from a central electric power plant or individual power generators should be considered. Assessment of potential impacts on utilities would include a review and analysis of

- Wastewater treatment requirements of the applicable Regional Water Quality Control Board or other governing authority;
- Availability of sufficient water supplies to serve the proposed action, or need for new or expanded entitlements;
- Availability of waste disposal facilities and landfills with sufficient permitted capacity to accommodate solid waste disposal needs;
- International treaties and Federal, state, and local statutes and regulations related to solid waste; and
- Capacity of the existing power supply providers and wastewater treatment providers to determine whether they could adequately serve the projected demand of the proposed action, in addition to the provider's existing commitments.

Determination of impacts on utilities also would include consideration of whether the proposed action would require or result in the construction of new water or wastewater treatment facilities, new storm water drainage facilities, or energy sources beyond permitted levels. Construction of new facilities or expansion of existing facilities has the potential to cause significant environmental impacts. It would be necessary to obtain appropriate permits for activities that may impact utility systems and facilities and to ensure compliance with local laws and regulations.

Site-specific analysis would be required to identify and, if appropriate, analyze potential impacts to a local utility system for individual activities for the proposed BMDS. For this reason, this PEIS will not include an analysis of the proposed BMDS activities' impacts on utilities.

Determination of Significance

Actions that would result in exceeding the existing capacity of the regional utility service providers (water supply, wastewater disposal, electricity, natural gas, solid waste disposal) and would require the identification or development of new utilities, supplies (water, electricity, natural gas), or disposal facilities (wastewater treatment facilities or solid waste disposal facilities) and their associated utility transmission corridors would be considered significant.

3.1.14 Visual Resources

Definition and Description

Visual resources are defined as the natural and man-made features that constitute the aesthetic qualities of an area. Landforms, surface water, vegetation, and man-made features are the fundamental characteristics of an area that define the visual environment and form the overall impression that an observer receives of an area. The importance of visual resources and any changes in the visual character of an area is influenced by social

considerations, including the public value placed on the area, public awareness of the area, and community concern for the visual resources in the area.

The visual resources of an area and any proposed changes to these resources can be evaluated in terms of "visual dominance" and "visual sensitivity." Visual dominance describes the level of noticeability that occurs as the result of a visual change in an area. The levels of visual dominance vary from "not noticeable" to a significant change that demands attention and cannot be disregarded. Visual sensitivity depends on the setting of an area. Areas such as coastlines, national parks, and recreation or wilderness areas usually are considered to have high visual sensitivity, whereas heavily industrialized urban areas tend to have the lowest visual sensitivity.

The significance of visual effects is very subjective and depends upon the degree of alteration, the scenic quality of the area disturbed, and the sensitivity of the viewers. The degree of alteration refers to the height and depth of maximum cut and fill areas and the introduction of urban elements into an existing natural environment or a substantial increase of structural elements into an already urban environment, while acknowledging any unique topographical formation or natural landmark. Sensitive viewers are those who utilize the outdoor environment or value a scenic viewpoint to enhance their daily activity and are typically residents or recreation users. Changes in the existing landscape where there are no identified scenic values or sensitive viewers are considered less than significant. Also, it is possible to acknowledge a visual change as possibly adverse but not significant, because either viewers are not sensitive or the surrounding scenic quality is not high. Visual impacts also would occur if proposed development is inconsistent with existing goals and policies of jurisdictions in which the project is located.

Many environments are likely to include regions of rich aesthetic and visual resources as well as designated and undesignated natural areas of great beauty and scenic diversity. Visual resources may fall under several different designations including national forest; national monument; national, state, and county parkland; national wildlife refuges; wilderness areas; wild and scenic rivers; national trails; and privately owned land. Various roads also may be designated scenic byways due to their scenic, historic, and cultural qualities. Visually sensitive recreational areas or scenic highways may be located in close vicinity of a site where activities for the proposed BMDS may occur.

Installations where MDA activities for the proposed BMDS may occur are typically dominated by developed, high technology buildings and support facilities. Some existing military sites are relatively unobtrusive when viewed from surrounding areas; however, it is possible that a variety of visual and aesthetic resources may be located near sites where activities for the proposed BMDS may occur.

Impact Assessment

MDA activities could have aesthetic impacts associated with changes in either the built or natural environment. An impacts analysis should include the length of visual disturbance (short- or long-term).

Assessment of potential impacts on visual resources should include a review and analysis of

- Short-term visual impacts such as the presence of heavy machinery during construction of a project (large trucks, cranes, and other construction equipment would be visible within the construction zone and in surrounding areas only during the construction phase.);
- Long-term visual changes such as those associated with altering the existing visual environment by constructing buildings, including those with high vertical profiles;
- Existing scenic resource, including but not limited to trees, rock outcroppings, and historic buildings within a state scenic highway;
- Existing visual character or quality of a site and its surroundings;
- New sources of substantial light or glare, which could adversely affect day or nighttime views in the area (for example, nighttime lighting, particularly during construction can cause impacts to visual resources);
- Viewer concern, or the level of scenic importance based on expressed human concern for the scenic quality of land;
- Distance an area can be seen by observers and the degree of visible detail within that area; and
- Extent of modification that would occur as a result of the proposed action.

Numerous visual and aesthetic resources may be identified in a given environment and at or near BMDS installations located within that environment. As a result, site-specific environmental documentation will identify and, if appropriate, analyze potential impacts to visual and aesthetic resources located in the vicinity of sites where activities for the proposed BMDS may occur. For this reason, this PEIS will not include an analysis of the proposed BMDS activities' impacts on visual resources.

Determination of Significance

Actions that would be considered significant include those that involve structures or land alterations that are visually incompatible with or obtrusive to the existing visual setting and landscape, noticeably increase visual contrast and reduce the scenic quality rating, permanently block or disrupt existing views or reduce public opportunities to view scenic resources, or conflict with existing regulations and policies governing aesthetics and visual resources (e.g., National Historic Preservation Act).

3.1.15 Water Resources

Definition and Description

Water resources include surface water, ground water, and floodplains. Surface water resources consist of lakes, rivers, and streams. Surface water is important for its contributions to the economic, ecological, recreational, and human health of a community or locale. Storm water flows, which may be exacerbated by high proportions of impervious surfaces (e.g., buildings, roads, and parking lots), are important to the management of surface water. Storm water also is important to surface water quality because of its potential to introduce sediments and other contaminants into lakes, rivers, and streams.

Ground water consists of the subsurface hydrologic resources. It is an essential resource often used for potable water consumption, agricultural irrigation, and industrial applications. Ground water typically may be described in terms of its depth from the surface, aquifer or well capacity, water quality, surrounding geologic composition, and recharge rate.

Floodplains are areas of low-lying ground along a river or stream channel. Such lands may be subject to periodic or infrequent inundation due to rain or melting snow. Risk of flooding depends on topography, the frequency of precipitation events, and the size of the watershed above the floodplain. Often development in floodplains is limited to passive uses, such as recreational and preservation activities, to reduce the risks to human health and safety.

The National Water Quality Inventory summarizes the water quality assessments performed by state, local and Tribal governments. (EPA, 2000) Water quality standards consist of three elements: (1) designated uses assigned to water body (e.g., drinking, swimming, and fishing); (2) criteria to protect the designated use (e.g., chemical specific threshold limits); and (3) anti-degradation policy to prevent deterioration of current water quality. The status of the U.S. water quality in 2000 is described in Exhibit 3-10.

Exhibit 3-10. Summary of Quality of Assessed Rivers, Lakes, and Estuaries

Water Body Type	Total Size, approximate	Amount Assessed* (Percent of Total)	Good (Percent of Assessed)	Good but Threatened (Percent of Assessed)	Polluted (Percent of Assessed)
Rivers, kilometers [miles]	5.94 million (3.7 million)	19 percent	52 percent	98 percent	38 percent
Lakes, hectares [acres]	16.4 million (40.6 million)	43 percent	46 percent	8 percent	44 percent
Estuaries, square kilometers [square miles]	22,630 (87,370)	36 percent	45 percent	<43 percent	50 percent

Source: EPA, 2002
*Includes water bodies assessed as not attainable for one or more uses
Note: percentages may not add up to 100 percent due to rounding

The leading causes of impairment of rivers and streams include pathogens (bacteria), siltation (sedimentation), and habitat alterations, and the leading sources for these include agriculture, hydraulic modifications, and habitat modifications. The leading causes of impairment of lakes, ponds and reservoirs include nutrients, metals (primarily mercury), and siltation (sedimentation), and the leading sources for these include agriculture, hydraulic modifications, and urban runoff/storm sewers. The leading causes of impairment of estuaries include metals (primarily mercury), pesticides, and oxygen-depleting substances, and the leading sources for these include municipal point sources, urban runoff/storm sewers, and industrial discharges. (EPA, 2002)

Impact Assessment

MDA activities that could impact water resources include those that either alter the flow of surface water, supply of ground water, or in some way contribute foreign bodies (pollution, sediment) to these water resources.

Assessment of potential impacts on water quantity would include a review and analysis of activities that

- Increase the number of impervious surfaces in an environment such as construction of new roads, buildings, parking lots, launch pads or runways (these surfaces can impact storm water runoff and recharge of ground water sources); and

- Consume ground water or surface water for a particular facility (the availability of water resources varies between locations).

Assessment of potential impacts on water quality would also include a review and analysis of activities that result in emissions or discharge of pollutants to water resources such as

- Construction or operation activities that could contribute to the sedimentation of water bodies; and
- Causes of point and non-point source pollution such as transportation emissions and ground clouds from launch, runoff of deluge or wash down water, thermal discharges, debris impacts, and any plans for open burning/open detonation.

Individual construction projects and associated water demands cannot be considered at the programmatic level, but must be analyzed in site-specific environmental documentation that can assess the impacts of such activities. This PEIS addresses the general impacts of BMDS activities resulting in sedimentation and pollution on water resources.

Determination of Significance

Actions that would fill in jurisdictional wetlands at levels that exceed the criteria for a Nationwide Permit and would require consultation with the U.S. Army Corps of Engineers and the development and implementation of a mitigation plan would be considered significant. Actions that would violate or exceed existing National Discharge Elimination System or Total Maximum Daily Load standards or would degrade the Total Maximum Daily Load classification of a water body, or would violate existing international, Federal, or state water discharge treaties or regulations would be considered significant. Actions that occur within and do not comply with a state wellhead protection area and its management practices, a state coastal zone management program, or any new ground water or surface water extraction system that would affect the water table or flow rates that has not been coordinated with the appropriate regulatory agency would be considered significant.

3.2 Affected Environment

The Affected Environment discussion describes the particular characteristics of each resource area[47] within nine terrestrial biomes, the BOA, and the Atmosphere, which represent the land, air (atmosphere), water, and space environments where proposed BMDS activities are reasonably foreseeable. Each contains distinct plant and animal groups and political boundaries.

[47] Cultural resources, environmental justice, land use, socioeconomics, utilities and visual resources are not discussed in the biome descriptions because they are local in nature and are not analyzed in Chapter 4.

A biome is a large geographical area of distinctive plant and animal groups. The climate and geography of an area determine what type of biome can exist in that area. Major terrestrial biomes include deserts, forests, grasslands, mountains, tundra and associated surface water bodies. Major marine systems include intertidal zones (which include sandy beaches, rocks, estuaries, mangrove swamps and coral reefs), neritic zones (the relatively shallow ocean that extends to the edge of the continental shelf, where primary productivity depends on planktonic algae growing as deep as the light can reach), oceanic zones, and abyssal plains.

Detailed descriptions of the nine terrestrial biomes, the BOA, and the Atmosphere as addressed in this PEIS are found in Appendix H Biome Descriptions.

3.2.1 Arctic Tundra Biome

The Arctic Tundra Biome[48] discussion encompasses the arctic coastal regions that border the North Atlantic Ocean and Arctic Ocean. This biome includes coastal portions of the state of Alaska in the U.S., Canada, and Greenland (administered by Denmark). The global distribution of this biome is depicted in Exhibit 3-11.

The majority of the Arctic Tundra Biome is located north of the latitudinal tree line and consists of the northern continental fringes of North America from approximately the Arctic Circle northward. For example, Thule AFB, Greenland, which is located approximately 1,100 kilometers (700 miles) north of the Arctic Circle, is the northernmost installation where MDA activities for the proposed BMDS may occur. The Arctic Tundra Biome includes other coastal locations that may be situated south of the Arctic Circle but have a climate and ecosystem similar to that of inland Arctic Tundra. These sites are located on the islands of the Aleutian chain and include Eareckson Air Station, Shemya Island, Alaska, and Port of Adak, Adak, Alaska.

[48] Exhibit 3-11 shows the global location of the Arctic Tundra ecosystem. However, based on reasonably foreseeable locations for activities for the proposed BMDS to occur, the Affected Environment focuses on the coastal portions of this ecosystem.

Exhibit 3-11. Global Distribution of the Arctic Tundra Biome

Source: Modified from National Geographic, 2003a

3.2.1.1 Air Quality

The climate of the Arctic Tundra Biome is characterized as polar maritime with persistent overcast skies, high winds, frequent and often violent storms, and a narrow range of temperature fluctuation throughout the year. The average annual temperature is -28°Celsius (°C) (-18°Fahrenheit [°F]). Parts of the Arctic Tundra may be classified as desert due to low precipitation. Annual precipitation is light, often less than 200 millimeters (eight inches). Most precipitation falls as snow in October through November. However, because potential evaporation also is very low, the climate tends to be humid. The Arctic Tundra also is characterized by high winds, which can blow between 48 to 97 kilometers (30 to 60 miles) per hour.

Air quality in the Arctic Tundra Biome is considered good, however, some areas in and around urban centers are in non-attainment for CO.

3.2.1.2 Airspace

Airspace above U.S. military airfields in the Arctic Tundra Biome includes controlled airspace and operates under IFR. The Arctic Tundra Biome also includes regions that are located in international airspace and therefore, the procedures of the International Civil Aviation Organization (ICAO) are followed. Much of Alaska's aviation activity takes

place within existing MOAs, through a shared-use agreement, with information provided by the Special Use Airspace Information Service, which is a system operated by the U.S. Air Force under agreement with the FAA Alaskan Region to assist pilots with flight planning and situational awareness while operating in or around MOAs or Restricted Areas in interior Alaska. In Canada, the Air Navigation Services and Airspace Services of Transport Canada are responsible for issues involved with airspace utilization and classification, levels of service for Air Navigation Service facilities, and services, including weather, navigation, radar, and communication services. In Greenland, the Danish Civil Aviation Administration issues Notices to Airmen (NOTAMs) regarding restricted airspace.

Civilian, military, and private airports exist in the Arctic Tundra Biome. Civilian aircrafts generally fly along established flight corridors that operate under VFR.

3.2.1.3 Biological Resources

Tundra environments are characterized by treeless areas, which consist of dwarfed shrubs and miniature wildflowers adapted to a short growing season. Species resident in arctic tundra have evolved adaptations peculiar to high latitudes. Examples of land mammals found on the Arctic Tundra include shrews, hares, rodents, wolves, foxes, bears and deer. Several lakes in the Arctic Tundra region support a small, unique assemblage of freshwater fishes.

Wetlands are typical of the Arctic Tundra. Ecological reserves and wildlife refuges are found throughout the Arctic Tundra region. Disturbance caused by boats or aircraft usually is controlled by distance or altitude regulations in protected areas and advisory restrictions elsewhere. Sometimes boat activities, such as the use of horns, are restricted. Exhibit 3-12 gives distance/altitude restrictions currently in place in Arctic countries. Canada, Finland, Greenland, Russia, and the U.S. restrict the distance boats can approach breeding seabirds, but restrictions apply only to specific protected areas. Distance restrictions range from 15 meters (49 feet) for unmotorized boats in some reserves within Newfoundland, Canada, to 1,600 meters (5,250 feet) in reserves in the U.S.

Arctic countries restrict the altitude below which aircraft cannot fly over a seabird colony. In general, minimum altitudes are in the range of 300-500 meters (984 to 1,640 feet) but are higher over some reserves in the U.S. (700 meters [2,300 feet]). Canadian flight manuals advise a minimum altitude of over 600 meters (1,970 feet) when flying over bird concentrations. In Greenland, advisory rules are in place restricting disturbance to wildlife caused by mineral resource exploration and extraction (directed mainly at helicopters).

Exhibit 3-12. Regulated Activities Near Seabird Colonies in Arctic Regions

Country	Boat Distance (closest approach)	Boat Speed (maximum)	Aircraft Altitude (minimum)	Use of Boat Siren
Canada	20 meters (66 feet) – motorized[1] 15 meters (49 feet) – non-motorized 100 meters (328 feet) or 50 meters (164 feet) off murre colonies	--	300 meters (984 feet) April 1 – September 1 in Newfoundland province reserves, most large colonies are marked on aeronautical charts	Not explicitly restricted but not allowed if disturbance to colony occurs
Greenland	500 meters (1,640 feet) for some protected colonies	18 kilometers per hour (11 miles per hour)[2]	500 meters (1,640 feet)	--
U.S.	100 – 1,600 meters (328 – 5,250 feet)	--	500 – 700 meters (1,640 – 2,300 feet)	--

Source: Modified from Chardine and Mendenhall, 2003
[1]Provincial regulation; Gull Island, Witless Bay- mixed Atlantic Puffin, Black-legged Kittiwake, Common Murre colony. Boat tour operators presently exempt.
[2]Restriction in place for mineral exploration activities only

3.2.1.4 Geology and Soils

Under a protective layer of sod, water in the soil melts in summer to produce a thick mud that sometimes flows downslope to create bulges, terraces, and lobes on hillsides. The freeze and thaw of water in the soil sorts out coarse particles, giving rise to such patterns in the ground as rings, polygons, and stripes made of stones. The coastal plains have numerous lakes of thermokarst origin, formed by melting ground water.

Soil particles in the Arctic Tundra derive almost entirely from mechanical breakup of rock, with little or no chemical alteration. Continual freezing and thawing of the soil have disintegrated its particles. In the Arctic Tundra, the soil is very low in nutrients and minerals, except where animal droppings fertilize the soil. (Bailey, 1995) Below the soil is the tundra's permafrost, a permanently frozen layer of earth. The majority of the Arctic Tundra Biome resides on a layer of permafrost.

Geologic hazards in the Arctic Tundra Biome include earthquakes, volcanic activity, and avalanches.

3.2.1.5 Hazardous Materials and Hazardous Waste

Installations where MDA activities for the proposed BMDS may occur may store and use large quantities of hazardous materials, including a variety of flammable and combustible liquids. Procedures that comply with applicable laws and regulations for managing hazardous materials are developed to establish standard operating procedures for the correct management and storage of hazardous materials at installations. Due to the extreme climate, special measures may be necessary for storage and handling of hazardous materials in arctic areas.

Wastes generated by facilities that may be used for the proposed BMDS include oils, fuels, antifreeze, paint, paint thinner and remover, photo chemicals, pesticides, aerosol canisters, batteries, used acetone, sulfuric acid, and sewage sludge. Procedures that comply with applicable laws and regulations are developed for managing hazardous wastes at sites where activities for the proposed BMDS may occur.

3.2.1.6 Health and Safety

All activities associated with the proposed BMDS would comply with Federal, state, and local laws and regulations applicable to worker and environmental health and safety. The MDA would take every reasonable precaution during the planning and execution of the operations, training exercises, and test and development activities to prevent injury to human life or property. Health and safety procedures should be included in site-specific operating documents.

3.2.1.7 Noise

The principal sources of noise from missile defense operations are vehicular traffic and military activities, including aircraft operations, rocket testing, and rocket launches. Frequency and duration of noise from military activities vary as a factor of the irregular training schedules, and noise levels vary with the type of activities at these facilities. Sonic booms may be produced as a result of BMDS activities. Other sources of noise would result from construction activities. Measurements of ambient sound levels should be analyzed in site-specific environmental documents.

3.2.1.8 Transportation

Roadway travel in the Arctic Tundra Biome is generally limited due to the lack of roads in the vast, undeveloped terrain. The summer months experience the highest amount of traffic, due to tourism and good weather. The Arctic Tundra Biome includes railway systems that provide freight, passenger, and intermodal transportation across North America, as well as regional and local service railways. Given the vast area of the Arctic Tundra Biome and the limited road network, aircraft provide an alternate means of

transportation. Marine travel tends to be limited in the Arctic Tundra Biome due to glacial patches found throughout many waterways.

3.2.1.9 Water Resources

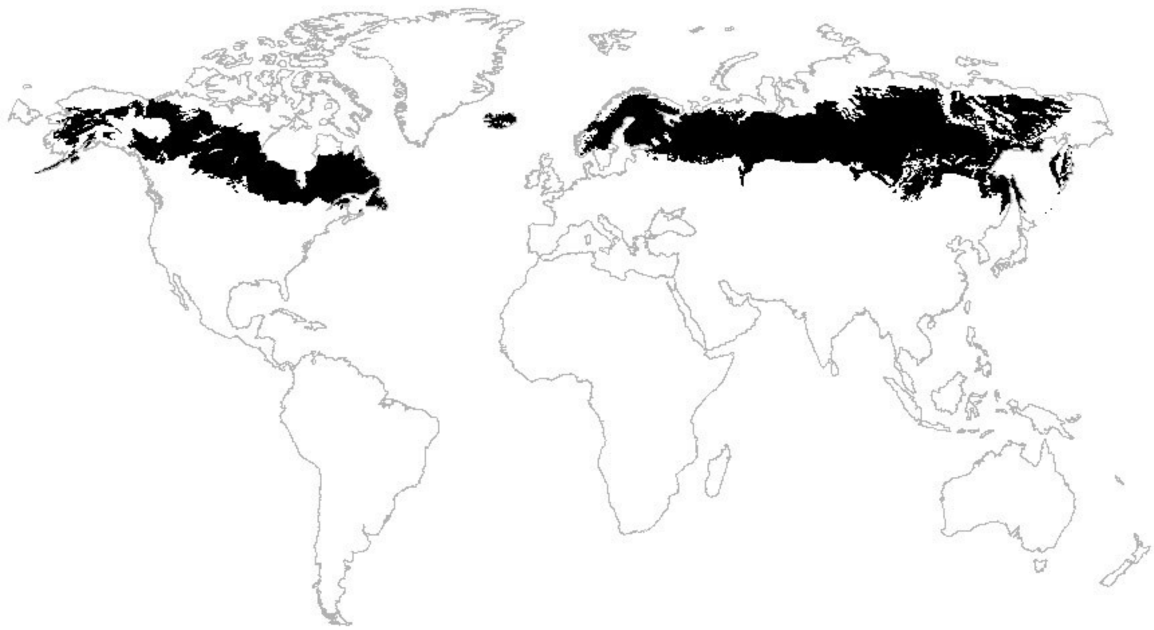
In the Arctic Tundra, alluvial deposits are the principal aquifers for ground water, which is greatly restricted by permafrost. During the summer when snow melts, the water percolates through the active layer but is unable to penetrate the permafrost. Pools of water form on the surface, and the active layer becomes saturated. Surface waters in the Arctic Tundra tend to be acidic and rich in organic material.

Surface water and ground water quality is generally good in the Arctic Tundra Biome except in isolated areas of known contamination. Although soils in the Arctic Tundra Biome are strongly acidic, pH of regional surface waters in North America is around 7, ranging from 6.8 to 7.5 in streams and 7.1 to 7.3 in lakes. The relatively high pH and capacity of streams and lakes to buffer acid inputs from natural and man-made sources are presumed to be the result of ions (e.g., calcium and magnesium) that have been carried into the atmosphere with sea spray and subsequently returned in rainfall. This is a common occurrence in coastal maritime regions. (Wetzel 1975, as referenced in FAA, 1996)

3.2.2 Sub-Arctic Taiga Biome

The Sub-Arctic Taiga Biome discussion focuses on the sub-arctic regions of North America, including portions of the state of Alaska. This biome is generally located between latitudes 50 and 60 degrees north (see Exhibit 3-13). The sub-arctic climate zone coincides with a great belt of needleleaf forest, often referred to as boreal forest, and with the open lichen woodland known as taiga. Existing inland sites found in Alaska in the Sub-Arctic Taiga Biome include Fort Greely (which includes Delta Junction), Clear Air Force Station, Eielson AFB, and Poker Flat Research Range.

Exhibit 3-13. Global Distribution of the Sub-Arctic Taiga Biome



Source: Modified From National Geographic, 2003b

Coastal sites also are located in the Sub-Arctic Taiga Biome, including portions of southwestern and western Alaska. Coastal sites are influenced by the cool climate generated by the cold waters of the North Atlantic Ocean and share maritime characteristics. Existing coastal sites where proposed BMDS activities may occur are found in Alaska in the Sub-Arctic Taiga Biome and include the KLC and the Port of Valdez.

3.2.2.1 Air Quality

The average temperature is below freezing for six months out of the year. Winter is the dominant season and the temperature range is -54°C to -1°C (-65°F to 30°F). Summers are mostly rainy, and humid, and temperatures range from –7°C to 21°C (20°F to 70°F). The total precipitation in a year is 30 to 85 centimeters (12 to 33 inches), which may fall as rain or snow or accumulate as dew. Surface winds along the coast are much stronger and more persistent than at inland areas.

Air quality in the Sub-Arctic Taiga Biome generally is considered favorable; however, some areas in and around urban centers, such as Anchorage and Fairbanks are in non-attainment for CO concentrations. These urban centers typically exceed CO NAAQS only during the winter (October through March).

Emissions from activities for the proposed BMDS include CO, NO_X, SO_X, VOCs, HAPs, and PM. In coastal areas, wind-blown volcanic dust is the primary air contaminant.

3.2.2.2 Airspace

Airspace above U.S. military airfields in the Sub-Arctic Taiga Biome generally includes controlled airspace and operates under IFR.

Much of Alaska's aviation activity takes place within existing MOAs, through a shared-use agreement, with information provided by the Special Use Airspace Information Service, which is a system operated by the U.S. Air Force under agreement with the FAA Alaskan Region to assist pilots with flight planning and situational awareness while operating in or around MOAs or Restricted Areas in interior Alaska.

There are approximately 600 civilian, military, and private airports and more than 3,000 airstrips in the state of Alaska. Existing military airfields, with runways that are paved and in good condition, would be used to support activities for the proposed BMDS.

Civilian aircraft generally fly along established flight corridors that operate under VFR.

3.2.2.3 Biological Resources

The vegetation of the Sub-Arctic Taiga Biome is primarily boreal forest, which is a complex array of plant communities shaped by fire, soil temperature, drainage, and exposure.

The interior areas of the Sub-Arctic Taiga Biome are populated with many animals that have evolved to meet conditions found at higher latitudes. All estuarine and marine areas out to the exclusive economic zone (322 kilometers [200 miles] from the coast) of the U.S. used by Alaskan Pacific salmon are designated as Essential Fish Habitat for salmon fisheries. Essential Fish Habitat also has been designated for scallops and Gulf of Alaska ground fish in the Port of Valdez. (U.S. Army Space and Missile Defense Command, 2003)

Most wetlands in the Sub-Arctic Taiga generally are classified as palustrine (non-flowing) or riverine, which occur alongside rivers and streams. On most wetlands in the sub-arctic region, wet soils result from a variety of sources, including the late melt of snow over either impervious subsoil layers such as glacial silts or discontinuous permafrost.

3.2.2.4 Geology and Soils

High mountains, broad lowlands, diverse streams and lakes, and complex rock formations characterize the geology of the Sub-Arctic Taiga Biome.

The boreal forest grows on poorly developed soils with pockets of wet, organic histosols. These light gray soils are wet, strongly leached, and acidic; they form a highly distinct layer beneath a topsoil layer of organic matter. Soils in the coastal areas are typically rocky, organic, or volcanic. The maritime taiga is characterized by poor drainage of surface water.

Geologic hazards in the Sub-Arctic Taiga Biome include earthquakes, volcanic activity, and avalanches.

3.2.2.5 Hazardous Materials and Hazardous Waste

Hazardous materials and hazardous waste in the Sub-Arctic Taiga Biome are similar to those found in the Arctic Tundra Biome described in Section 3.2.1.5.

3.2.2.6 Health and Safety

Health and Safety attributes of the Sub-Arctic Taiga Biome are similar to those discussed in Section 3.2.1.6.

3.2.2.7 Noise

The Sub-Arctic Taiga Biome generally is sparsely populated and most of the region is expected to have a background noise level of DNL less than or equal to 55 dBA.

3.2.2.8 Transportation

Transportation attributes of the Sub-Arctic Taiga Biome are similar to those discussed in Section 3.2.1.8.

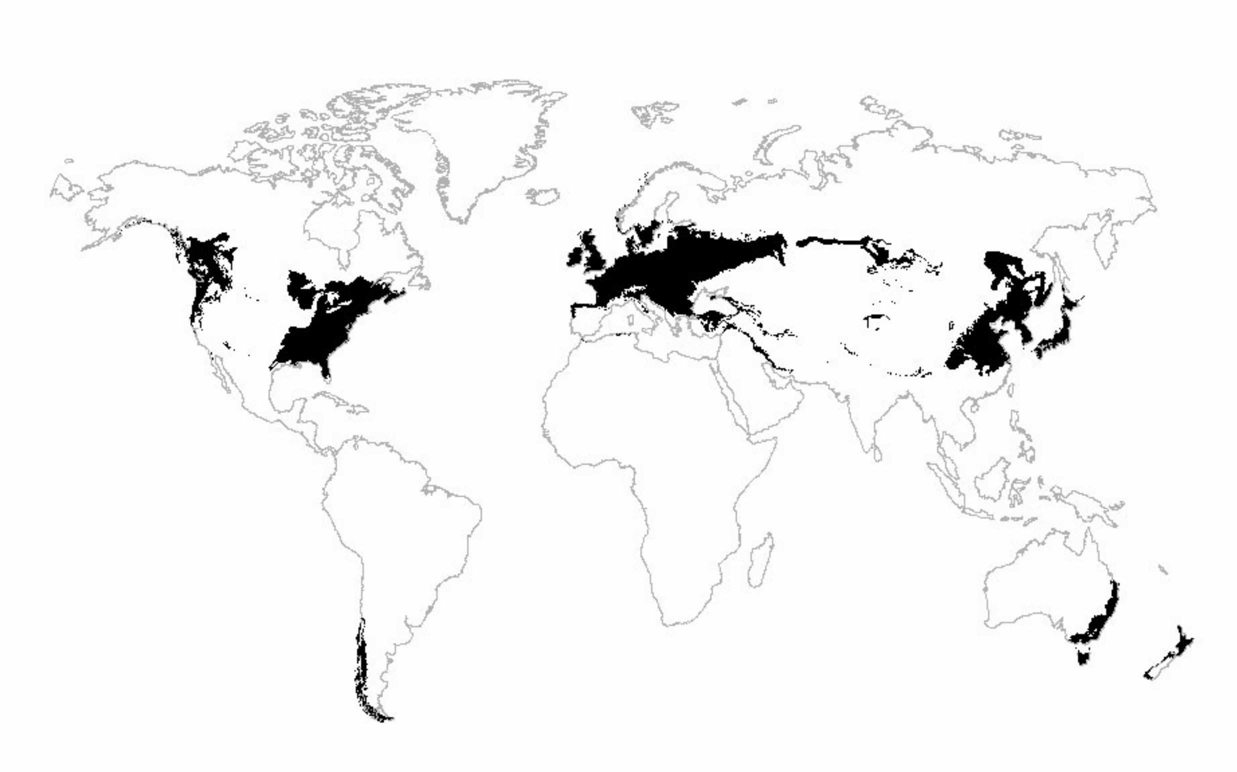
3.2.2.9 Water Resources

Ground water is supplied by rivers, precipitation, and melt water in the Sub-Arctic Taiga Biome. Characteristic of the taiga are innumerable water bodies, including bogs, fens, marshes, shallow lakes, rivers and wetlands, which are intermixed among the forest and hold vast amounts of water. In coastal areas, ground water is found primarily in river basins and recharged by infiltration of melt water from precipitation and glaciers. Water quality is subject to seasonal variations, but remains within established EPA drinking water standards.

3.2.3 Deciduous Forest Biome

As shown in Exhibit 3-14, the Deciduous Forest Biome includes the deciduous forest regions of North America, which include most of the eastern portion of the U.S. and parts of central Europe and East Asia. The description in this section of the U.S. deciduous forest is representative of this biome throughout the world.

Exhibit 3-14. Global Distribution of the Deciduous Forest Biome



Source: Modified From National Geographic, 2003b

Existing inland sites in the Deciduous Forest Biome include Redstone Arsenal, Alabama; Fort Devens, Massachusetts; and Aberdeen Proving Ground, Maryland.

Coastal sites also are located in the Deciduous Forest Biome. These sites share maritime characteristics. Existing coastal sites include Naval Air Station Patuxent River, Maryland; Wallops Island, Virginia; Cape Canaveral Air Force Station, Florida; Cape Cod Air Force Station, Massachusetts; and Eglin AFB, Florida.

3.2.3.1 Air Quality

The average annual temperature in a deciduous forest is 10°C (50°F). The average rainfall is 76 to 152 centimeters (30 to 60 inches) a year, with nearly 36 centimeters (14 inches) of rain in the winter and more than 46 centimeters (18 inches) of rain in the

summer. Humidity in these forests is high, ranging from 60 to 80 percent. Because of its location, air masses from both the cold polar region and the warm tropical region contribute to the climate changes in this biome.

Many metropolitan regions on the U.S. Atlantic Coast are in non-attainment for EPA's NAAQS for ozone, the primary constituent of urban smog. The southern Atlantic coast from Virginia through Florida is in attainment for all criteria air pollutants. However, the entire coastal area from northern Virginia through Maine is in non-attainment for ozone (ranging from moderate to severe), and small areas in Connecticut are in moderate non-attainment for PM_{10}.

Emissions from activities for the proposed BMDS include CO, NO_X, SO_X, VOCs, HAPs, and PM. Existing emissions sources in the coastal areas of the Deciduous Forest Biome are primarily the same as for those in the inland areas.

3.2.3.2 Airspace

The Deciduous Forest Biome in the U.S. contains all FAA classifications for airspace, as described in Section 3.1.2.

3.2.3.3 Biological Resources

On numerous sites where activities for the proposed BMDS may occur, native vegetation has been removed, and the land is landscaped and maintained by mowing and brush control measures. Isolated pockets of vegetation may remain on sites where activities for the proposed BMDS may occur, however, vegetation on off-site areas is widespread and may be undisturbed.

The Deciduous Forest Biome provides habitat for a wide variety of animals. State and federally endangered and threatened species in the biome include but are not limited to red-cockaded woodpeckers and the northeastern tiger beetle.

The Florida Keys have been designated a National Marine Sanctuary, Outstanding Florida Waters, and an Area of Critical State Concern. In addition, the Deciduous Forest Biome includes critical habitat. For example, critical habitat for the Northern Right whale (*Eubalaena glacialis*) is designated for portions of Cape Cod Bay and Stellwagen Bank, the Great South Channel (each off the coast of Massachusetts) and waters adjacent to the coasts of Georgia and the east coast of Florida.

3.2.3.4 Geology and Soils

The geology of the Deciduous Forest inland is varied and consists of low mountains and plateaus. The Coastal Plain is predominantly flat and is covered with terrestrial sediments.

There are two types of soil found in deciduous forests in the U.S. Fertile soils with high organic content are rich in nutrients and have well-developed layers of clay. The second type, the "red clay" soils are found in humid temperate and tropical areas of the world, typically on older, stable landscapes. In coastal areas of this biome, soils are predominantly deep and adequately drained.

Because limited seismic activity occurs along the Atlantic continental shelf, the risk of an earthquake in the Deciduous Forest Biome is low. Volcanic activity generally is not observed along the U.S. Atlantic and Gulf Coasts, however, cracks present in the Eastern Seaboard have the potential to cause the seabed to crumble and create a tsunami that would push huge masses of sea water toward the coast. Landslides are a significant geologic hazard throughout the Deciduous Forest Biome.

3.2.3.5 Hazardous Materials and Hazardous Waste

Hazardous materials and hazardous waste attributes of the Deciduous Forest Biome are similar to those discussed in Section 3.2.1.5. Except the moderate climate characteristic of the Deciduous Forest Biome does not require special consideration as is necessary in the extreme temperatures of the Arctic Tundra Biome.

3.2.3.6 Health and Safety

Health and Safety attributes of the Deciduous Forest Biome are similar to those discussed in Section 3.2.1.6.

3.2.3.7 Noise

The Eastern Range is a representative example of noise levels for sites where activities for the proposed BMDS may occur in the Deciduous Forest Biome. Ambient noise levels based on daytime monitoring, range from 60 dBA to 80 dBA. (DOT, 2001) Noise sources associated with the proposed BMDS are similar to those described in Section 3.2.1.7.

3.2.3.8 Transportation

The Deciduous Forest Biome includes both coastal and inland regions that sustain widespread infrastructure, including marine ports and docks that are supported by traffic

circulation systems such as highways and byways, unpaved roads, non-maintained roads, trails, railroad lines, municipal, private, and military airports and any other system involved in mass transportation.

On-site roadways provide access to launch complexes, support facilities, and industrial areas. Railways transport both cargo and passengers in the region.

There are numerous commercial, private, and military airports within the Deciduous Forest Biome. They vary in size from major international airports such as Hartsfield-Jackson Atlanta International Airport in Georgia that supports 80 million passengers each year to small, rural airstrips that support single engine planes.

The top ports in U.S. foreign trade are deep draft (drafts of at least 12 meters [40 feet]). Twenty-five U.S. ports, located within the Deciduous Forest Coastal Biome, received 73 percent of total vessel calls. (DOT BTS, 2001)

3.2.3.9 Water Resources

Ground water provides about 40 percent of the U.S. public water supply. Where water demand is great, sophisticated reservoir, pipeline, and purification systems are needed to meet demands. Ground water resources along the coast are vulnerable to saltwater intrusion and nutrient contamination. (USGS, 2000)

Water quality in the Deciduous Forest Biome varies depending on pressures from human activity (e.g., industrial effluents and agricultural run-off). Pollution of coastal waters often results from runoff laden with particulates and other pollutants; sewage treatment plants; combined sewer overflows; and storm drains that discharge liquid waste directly into the ocean through pipelines, dumping of materials dredged from the bottoms of rivers and harbors, and waste from fish processing plants, legal and illegal dumping of wastes from ships and ground water from coastal areas.

3.2.4 Chaparral Biome

The Chaparral Biome includes regions corresponding to those shown in Exhibit 3-15, but focuses on a portion of the California Coast and the coastal region of the Mediterranean from the Alps to the Sahara Desert and from the Atlantic Ocean to the Caspian Sea. Representative sites where activities for the proposed BMDS may occur are part of the Western Range, including Vandenberg AFB and the Point Mugu Sea Range.

Exhibit 3-15. Global Distribution of the Chaparral Biome

Source: Modified From National Geographic, 2003b

3.2.4.1 Air Quality

The Chaparral climate consists of hot summer drought and winter rain in the mid-latitudes, north of the subtropical climate zone. The climate in this area is unique with the wet season occurring in winter and annual rainfall of only 38 to 102 centimeters (15 to 40 inches). Cold ocean currents and fog affect temperatures, which limit the growing season. The high-pressure belts of the subtropics drift northwards in the Northern Hemisphere from May to August and they coincide with substantially higher temperatures and little rainfall. During the winter, weather becomes dominated by the rain-bearing low-pressure depressions. While usually mild, such areas can experience cold snaps when exposed to the icy winds of the large continental interiors, where temperatures can drop to -40°C (-40°F) in the extreme continental climates. (Atmosphere, Climate and Environment Programme, 2003)

The primary sources of air pollutants in coastal areas include stationary sources, area sources, mobile sources, and biogenic sources such as forest fires. VOCs react with sunlight in the atmosphere to produce ozone (i.e., smog). In some areas, background levels of air pollutants are relatively high due to air currents depositing pollution from sources outside of the coastal area.

There is a large area along the Pacific coast, particularly in southern California that is in non-attainment for ozone (ranging from severe to extreme). A large area in southern California is in severe non-attainment for PM_{10}. (EPA, 2003f) The EPA has designated the near shore areas of southern California as unclassified/attainment areas. Due to the lack of major emissions sources in the area and the presence of strong northeast winds, the likelihood of pollutants remaining in the ambient air is low.

Heavy industrial activities, high automobile traffic, and energy generation are the main sources of air pollutants along the southern Pacific coast.

The European Union eight-hour air quality standard for ozone (53 nmol/mol) is exceeded throughout the summer in the entire Mediterranean region.

3.2.4.2 Airspace

Airspace in coastal regions of North America contains “North American Coastal Routes,” which are numerically coded routes preplanned over existing airways and route systems to and from specific coastal fixes. See Section 3.1.2 for a description of North American Routes.

Portions of the Chaparral Biome are located in international airspace. Therefore, the procedures of the ICAO (outlined in ICAO Document 444, Rules of the Air and Air Traffic Services) are followed.

There are numerous restricted areas in the near shore environment associated with the Western Range. The procedures for scheduling each portion of airspace are performed in accordance with letters of agreement with the controlling FAA facility, Los Angeles Air Route Traffic Control Center (ARTCC).

Numerous airports and airfields exist within the Chaparral Biome. Numerous jet routes that cross the Pacific pass through the U.S. Chaparral Biome, including A331, A332, A450, R463, R465, R584, Corridor V506 and Corridor G10.

3.2.4.3 Biological Resources

The vegetation of the Chaparral is characterized by the presence of hard, tough, evergreen leaves and low, shrubby appearance.

Birds of the Chaparral include the endangered California gnatcatcher (*Polioptila californica*), California thrasher (*Toxostoma redivivum*), western scrub jay (*Aphelocoma californica*), and cactus wren (*Campylorhynchus brunneicapillus*).

The near shore and coastal environment of the Chaparral Biome support numerous threatened or endangered species.

The Chaparral Biomes around the world support 20 percent of all plants, but these areas are all relatively small and many are threatened. Essential Fish Habitat includes those waters and sediment that are necessary to complete the life cycle for fish from spawning to maturity. There are two Essential Fish Habitat zones in this region, coastal pelagic and groundfish.

3.2.4.4 Geology and Soils

The California Coastal Chaparral area consists of narrow ranges with wide plains in between, as well as alluviated lowlands and coastal terraces.

The soils of the Chaparral Biome may be classified into four categories, coastal beach sands, tidal flats, loamy sands, and silty clay. The erosion hazard of these soils depends on slope and vegetation cover.

The California Chaparral Coastal area is noted for its intense seismic activity due to the right lateral motion of the Pacific and North Atlantic Plate boundary.

3.2.4.5 Hazardous Materials and Hazardous Waste

Hazardous materials and hazardous waste attributes of the Chaparral Biome are similar to those discussed in Section 3.2.1.5. Except the moderate climate characteristic of the Chaparral Biome does not require special consideration as is necessary in the extreme temperatures of the Arctic Tundra Biome.

3.2.4.6 Health and Safety

Health and Safety attributes of the Chaparral Biome are similar to those discussed in Section 3.2.1.6.

3.2.4.7 Noise

Vandenberg AFB is a representative example of noise levels for sites where activities for the proposed BMDS may occur in the Chaparral Biome. Ambient noise levels at Vandenberg AFB range from 48 dBA to 67 dBA. (DOT, 2001) Noise sources associated with the proposed BMDS are described in Section 3.2.1.7.

3.2.4.8 Transportation

Transportation attributes of the Chaparral Biome are similar to those discussed in Section 3.2.3.8.

3.2.4.9 Water Resources

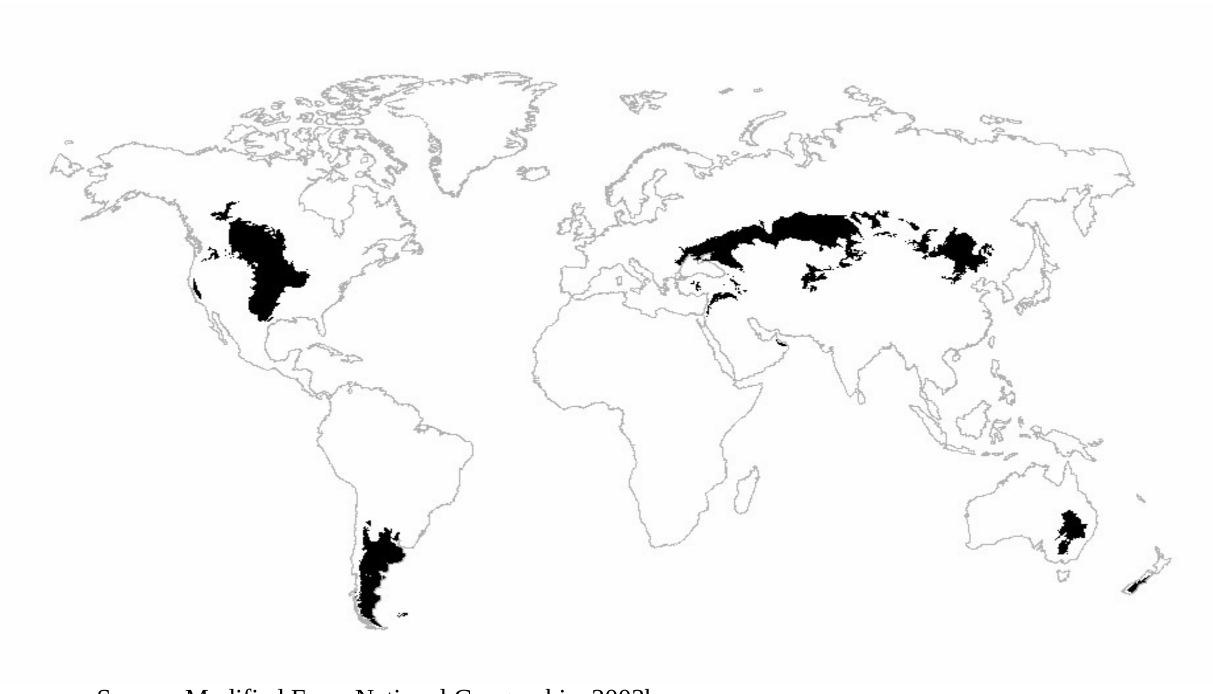
Very few perennial streams occur in the Southern California coastal area. There is relative scarcity, on a per capita basis, of freshwater supplies in Mediterranean regions, where agriculture competes for freshwater with growing tourism and industrial use. (UNEP Plan Bleu, 2000)

Water quality attributes of the Chaparral Biome are similar to those described in Section 3.2.3.9.

3.2.5 Grasslands Biome

As shown in Exhibit 3-16, the Grasslands Biome includes the grasslands of North and South America, Eurasia, and Australia. The description in this section is representative of this biome throughout the world. Currently there are no active sites in the Grassland Biome where activities for the BMDS are proposed to occur. However, past military installations within this biome make it reasonable foreseeable that future activity proposed for the BMDS could occur there. There are no reasonably foreseeable coastal sites located in the Grasslands Biome.

Exhibit 3-16. Global Distribution of the Grasslands Biome



Source: Modified From National Geographic, 2003b

3.2.5.1 Air Quality

In the Grasslands Biome, approximately 25 to 76 centimeters (10 to 30 inches) of precipitation falls annually. The temperature varies due to the vast latitudinal span of the grasslands, with annual temperatures ranging from -20ºC to 43°C (-4ºF to 104°F). The average annual temperature across the Grasslands Biome is 24°C (43°F). The low humidity of the Grasslands Biome arises because mountain barriers block warm, moist air from oceans.

Air pollution issues of special concern to the Grasslands Biome are emissions from open burning and fugitive dust.

Due to the low population density of most grassland areas, biogenic (naturally occurring) activities are the predominant sources of air pollution emissions in this biome.

3.2.5.2 Airspace

The U.S. Grassland Biome contains all FAA airspace classifications, as described in Section 3.1.2.

3.2.5.3 Biological Resources

Short grasses, which are predominant throughout the Grasslands Biome, have adapted physiological responses to widespread drought and fire.

Naturally occurring grasslands are becoming harder to find due to human encroachment that can be attributed to increasing population pressures, desire for farmland, and oil exploration, among others. Biological resources of particular concern in the biome are migrating waterfowl and ephemeral prairie potholes.

3.2.5.4 Geology and Soils

The predominant soil type found throughout the Grasslands Biome is characterized by a thick, dark surface horizon resulting from the long-term addition of organic matter derived from plant roots.

There are no significant geological hazards within the Grasslands Biome.

3.2.5.5 Hazardous Materials and Hazardous Waste

Hazardous materials and hazardous waste attributes of the Grasslands Biome are similar to those discussed in Section 3.2.1.5, except that the moderate climate characteristic of

the Grassland Biome does not require special consideration as is necessary in the extreme temperatures of the Arctic Tundra Biome.

3.2.5.6 Health and Safety

Health and Safety attributes of the Grasslands Biome are similar to those discussed in Section 3.2.1.6.

3.2.5.7 Noise

Noise sources associated with the proposed BMDS are similar to those described in Section 3.2.1.7.

3.2.5.8 Transportation

Railroads and motor carriage (i.e., trucking) are the backbone of the freight transportation system in the Grasslands region. The highway system in the prairies consists largely of rural roads, many of which are local roads that are maintained by county and township governments.

3.2.5.9 Water Resources

Sources of water in the Grasslands Biome include precipitation, ground water in aquifers, and surface water in rivers, streams, lakes, and wetlands. Due to the heavy dependence on underground water systems for irrigation of the plains' extensive farmland (and to a lesser extent for municipal water systems and industrial development), the depletion of the Grassland Biome's aquifers is of special concern.

The quality of water in the High Plains aquifer generally is suitable for irrigation use, but in many places, the water does not meet EPA drinking water standards with respect to several dissolved constituents: dissolved solids/salinity, fluoride, chloride, and sulfate. (USGS, 2003)

3.2.6 Desert Biome

The Desert Biome includes the desert regions of North America, which include the western arid environment of the southwestern U.S. (See Exhibit 3-17) The description in this section of the U.S. desert is representative of this biome throughout the world. Existing inland sites in the Desert Biome include WSMR, New Mexico; Fort Bliss, Texas; Edwards AFB, California; and the Nevada Test Site, Nevada.

Exhibit 3-17. Global Distribution of the Desert Biome

Source: Modified From National Geographic, 2003b

3.2.6.1 Air Quality

In cold desert regions, temperatures range from 2ºC to 4ºC (36ºF to 39ºF) in the winter and from 21ºC to 26ºC (70ºF to 79ºF) in the summer. Total annual precipitation averages 15 to 26 centimeters (six to ten inches). In contrast, hot desert regions have average monthly temperatures above 18ºC (64ºF), with typical temperatures ranging from 20ºC to 25ºC (68ºF to 77ºF). Hot desert regions usually have very little precipitation annually and/or concentrated precipitation in short periods, totaling less than 15 centimeters (six inches) per year.

A unique pollutant of concern in desert regions is dust, i.e., PM, which contributes to desertification, the process of creating deserts. Activities that expose and disrupt topsoil, such as grazing and agricultural cultivation common throughout the western U.S., can increase the amount of dust released into the air.

The predominant source of air pollution in the Desert Biome is agriculture, which disturbs the surface layer soil and emits dust into the air.

3.2.6.2 Airspace

The U.S. Desert Biome contains all FAA classifications for airspace, as described in Section 3.1.2.

3.2.6.3 Biological Resources

The Desert Biome encompasses three major vegetation types: semi-desert grassland, plains-mesa sand scrub, and desert scrub.

Desert animals include small nocturnal carnivores, insects, arachnids, reptiles, and birds.

3.2.6.4 Geology and Soils

Nearly 50 percent of desert surfaces are plains where the removal of fine-grained material by wind has exposed loose gravels consisting predominantly of pebbles and occasional cobbles, forming "desert pavement." The remaining surfaces of the Desert Biome are composed of exposed bedrock outcrops, desert soils, and fluvial deposits, including alluvial fans (a cone-shaped deposit of sediments), playas (dry lake beds), desert lakes, and oases. Bedrock outcrops commonly occur as small mountains surrounded by extensive erosional plains.

Desert soils are predominately mineral soils with low organic content. Poorly drained areas may develop saline soils and dry lakebeds may be covered with salt deposits. Geologic hazards within the Desert Biome include earthquakes and landslides.

3.2.6.5 Hazardous Materials and Hazardous Waste

Hazardous materials and hazardous waste attributes of the Desert Biome are similar to those discussed in Section 3.2.1.5.

3.2.6.6 Health and Safety

Health and Safety attributes of the Desert Biome are similar to those discussed in Section 3.2.1.6.

3.2.6.7 Noise

Ambient noise levels for remote desert environments range from 22 to 38 dBA. Ambient noise levels at a representative site where activities for the proposed BMDS may occur within the Desert Biome range from 65 dBA to 85 dBA at Edwards AFB and from 45 dBA to 65 dBA at WSMR. (DOT, 2001) Noise sources associated with the proposed BMDS are described in Section 3.2.1.7.

3.2.6.8 Transportation

Because the population density is so low and dispersed throughout most of the region, transportation infrastructure is concentrated near metropolitan centers.

3.2.6.9 Water Resources

In the Desert Biome, droughts and aquifer supply issues are of particular concern. The leading causes of impairment of rivers and streams include pathogens (bacteria), siltation (sedimentation), and habitat alterations, and the leading sources for these include agriculture, hydraulic modifications, and habitat modifications.

3.2.7 Tropical Biome

The Tropical Biome[49] encompasses areas within the Pacific and Atlantic Oceans. (See Exhibit 3-18) The coastal zone stretches 1,000 meters (3,281 feet) inland of the coastal shoreline, tidal wetlands, coastal wetlands, and coastal estuaries. (Coastal Planning Coalition of Australia, 2003) Because many of the islands within the Pacific and Atlantic Oceans are relatively small, the entire island may be considered within this Affected Environment section.

The Pacific Tropical Biome would include islands found within the equatorial region. The Pacific contains approximately 25,000 islands, the majority of which are found south of the equator. (Wikipedia, 2003) Current Ranges within this biome where activities of the proposed BMDS may occur include PMRF, U.S. Army Kwajalein Atoll (USAKA), Wake Island, and Midway.

The majority of islands in the Atlantic Tropical Biome are in the Caribbean between the Caribbean Sea and the North Atlantic Ocean.

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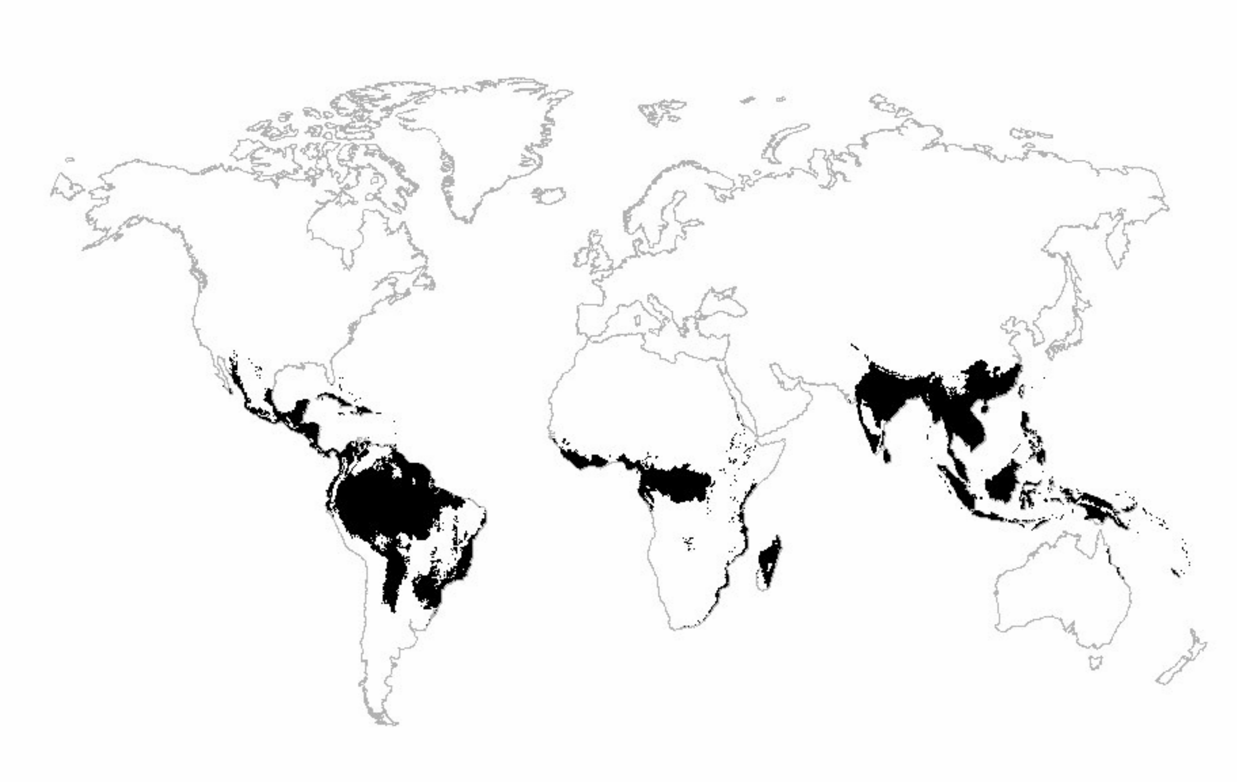
[49] Exhibit 3-18 shows the global location of the Tropical ecosystem. However, based on reasonably foreseeable locations for activities for the proposed BMDS to occur, the affected environment focuses on the coastal portions of this ecosystem.

Exhibit 3-18. Global Distribution of the Tropical Biome



Source: Modified From National Geographic, 2003b

3.2.7.1 Air Quality

The climate for the Tropical Biome is tropical marine to semi-tropical marine, characterized by relatively high annual rainfall and warm to hot, humid weather throughout the year. Steadily blowing trade winds allow for relatively constant temperatures of 21°C to 27°C (70°F to 81°F) throughout the year. The annual rainfall in the Tropical Biome is approximately 127 to 1,016 centimeters (50 to 400 inches).

Ambient air quality monitoring data are not readily available for islands in the Pacific. In the Caribbean, and Latin America generally, increasing urbanization and rampant forest destruction have led to considerable air quality degradation.

Because of the relatively small numbers and types of air pollution sources, dispersion caused by trade winds, and lack of topographic features at most locations, air quality in the equatorial region is considered good (i.e., well below the maximum pollution levels established for air quality in the U.S.). (U.S. Army Space and Missile Defense Command, 2003)

3.2.7.2 Airspace

The majority of islands in the Pacific Tropical Coastal region are located in international airspace and therefore, the procedures of the ICAO are followed. The Atlantic Pacific Coastal region consists of both U.S. and international airspace.

The procedures for scheduling each portion of airspace are performed in accordance with letters of agreement with the controlling FAA facility.

There are numerous Range-affiliated airport and airfields located within the Pacific Tropical Coastal Affected Environment, including Wake Island, USAKA, PMRF, and Midway. Many of these airfields are engaged in activities similar to those of the proposed activities. Future test events would act in accordance with existing activities at the airfields. The majority of local airports within the Atlantic Tropical Coastal region handle smaller, private aircraft, which are uncontrolled.

High-altitude overseas jet routes cross the Pacific Tropical Coastal region via nine Control Area Extension corridors off the California coast.

3.2.7.3 Biological Resources

Vegetation and wildlife in the Tropical Biome is among the most biologically diverse in the world.

There are numerous environmentally sensitive habitats within the Tropical Biome, including barrier reefs, whale sanctuaries, and fisheries.

3.2.7.4 Geology and Soils

Islands within the Pacific Tropical Biome range from atolls with small, low inlets and extensive lagoons, to raised limestone islands, to volcanic high islands with substantial topographic and internal climatic diversity. Coral reefs have developed upon the eroded platforms around some of the islands.

Islands within the Atlantic Tropical Biome are composed of two distinctive chains of islands, the Lesser and Greater Antilles. The islands are characterized by a range of geological formations, from volcanic and sedimentary strata to coral limestone and alluvium.

The soils on smaller atolls in the Pacific Ocean have low fertility due to alkalinity. The soils are permeable, and infiltration is rapid. Wind erosion is severe when vegetation has been removed.

The islands within the Atlantic Tropical Biome include a wide range of soils, which may be derived from limestone, serpentine, dolomite, basalt, granite, diorite, gabbro, sandstone, or slate.

Volcanic islands within the Pacific Ocean have been built of successive lava flows. Volcano eruptions occur relatively frequently on the islands. (NOAA, 2003b)

In the Atlantic region, many earthquakes and tsunamis have occurred in the northeastern Caribbean, where the movements of the Earth's surface plates are rapid and complicated. (USGS, 2001) Volcanoes erupt on the eastern and western sides of the Caribbean plate.

3.2.7.5 Hazardous Materials and Hazardous Waste

Hazardous materials and hazardous waste attributes of the Tropical Biome are similar to those discussed in Section 3.2.1.5. However, the moderate climate characteristic of the Desert Biome does not require consideration as is necessary in the extreme temperature of the Arctic Tundra Biome.

3.2.7.6 Health and Safety

Health and Safety attributes of the Tropical Biome are similar to those discussed in Section 3.2.1.6.

3.2.7.7 Noise

Natural background sound levels in the Tropical Biome are relatively high due to wind and surf. Sources of noise in the Tropical Biome are similar to principle sources of noise associated with sites where activities for the proposed BMDS may occur, as described in the Section 3.2.1.7.

3.2.7.8 Transportation

The smaller islands may require marine transport vessels to transport passengers and supplies between islands. The isolated locations of the equatorial environments make transportation vital to many of the locations. Ground transportation facilities consist of roadways and pathways used by motor vehicles, bicycles, and pedestrians. Ships and smaller craft carry ocean cargo and fuel to the Equatorial Islands and deliver workers and cargo, including fuel, between islands.

3.2.7.9 Water Resources

Seasonal rainfall is the primary source of freshwater for most small islands. Catchments are used to capture rainfall for potable use. Raw water is stored in aboveground storage

tanks. Coastal areas of the Caribbean near major watersheds often contain large lagoons of fresh or brackish water.

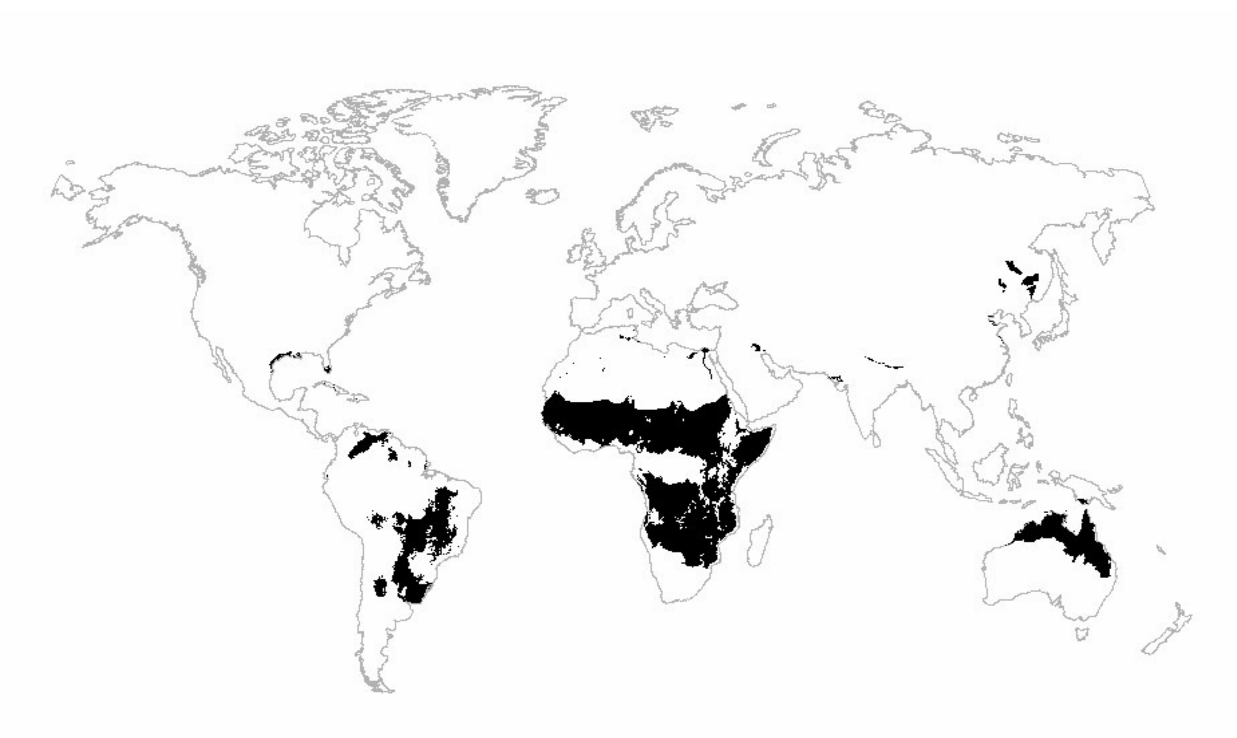
Of the land-based sources of pollution, eutrophication, or nutrient enrichment, from human sewage disposal is a growing problem in the Caribbean, particularly in the vicinity of large coastal cities and harbors.

Pacific Island water quality is generally of very high, with high dissolved oxygen and pH at levels typical of mid-oceanic conditions.

3.2.8 Savanna Biome

The Savanna Biome includes the transitional zone between the tropical forest and the semi-desert scrub vegetation types and typically occupies latitudes between 5º and 20º North and South of the equator (see Exhibit 3-19). Savannas cover extensive areas in the tropics and subtropics of Central and South America, Central and South Africa, and northern Australia in both inland and coastal environments. Currently there are not sites in the Savanna Biome where activities are proposed for the BMDS; however, it is reasonably foreseeable that future activity for the BMDS could occur here. The description in this section is representative of this biome throughout the world.

Exhibit 3-19. Global Distribution of the Savanna Biome



Source: Modified From National Geographic, 2003b

3.2.8.1 Air Quality

Towards the equator, annual rainfall is typically higher relative to the more poleward edges of the Savanna belt, and total annual precipitation may be as high as 250 centimeters (98 inches). On the Savanna edges nearest the tropics (towards the poles), annual rainfall totals may be as little as 50 centimeters (20 inches). In Australian savanna environments, coastal areas receive twice as much rainfall as inland savannas.

Annual temperatures in the Savanna Biome are relatively constant, averaging roughly 24ºC to 27ºC (75ºF to 80ºF).

The Savanna Biome faces similar air quality concerns as those found in the Grassland Biome, namely emissions from open burning, natural drought-driven fires, and other fugitive dust.

Fire is a predominant emission source, while anthropogenic activities, such as agriculture and mining also contribute.

3.2.8.2 Airspace

The Savanna Biome is located in international airspace; and therefore, the procedures of the ICAO are followed.

3.2.8.3 Biological Resources

Savannas are characterized by a continuous cover of perennial grasses, often one to two meters (three to six feet) tall at maturity. They also may have an open canopy of drought- or fire-resistant trees or an open shrub layer.

National parks and reserves have been established to preserve and protect threatened vegetative and wildlife species in the Savanna Biome. However, the parks are vastly under funded and often poorly managed.

3.2.8.4 Geology and Soils

Savannas typically have porous (often sandy) soil, with only a thin covering of nutrient-rich humus and an overall low concentration of nutrients.

Savannas are similar to grasslands in geologic and topographic features, predominantly characterized by flat terrain and may be marked with escarpments and other plateau-like features of sandstone or limestone composition. There are no significant geological hazards throughout the Savanna Biome.

3.2.8.5 Hazardous Materials and Hazardous Waste

There are no existing facilities proposed for use in the BMDS in the Savanna Biome. However, future sites would use hazardous materials similar to those in use at existing sites discussed in this chapter and would produce similar hazardous wastes.

Any future facilities that may be used as part of the proposed BMDS would adhere to all applicable legal requirements for hazardous materials and hazardous waste management as described in Section 3.1.7.

3.2.8.6 Health and Safety

Health and safety attributes of the Savanna Biome are similar to those discussed in Section 3.2.1.6.

3.2.8.7 Noise

Noise sources associated with the proposed BMDS in the Savanna Biome are similar to those described in Section 3.2.1.7.

3.2.8.8 Transportation

Transportation in the Savanna Biome is typically limited due to the frequently remote and rural nature of savannas. Highways, if present, are typically unpaved and may not be regularly maintained due to the low volume of traffic carried and remote locations. Railways are not a dominant form of transportation in the Savanna Biome.

Airports with paved runaways are scarce in the Savanna Biome.

Navigable waterways are present in some wetter savannas and may be used to transport goods to ports along coastal savannas.

3.2.8.9 Water Resources

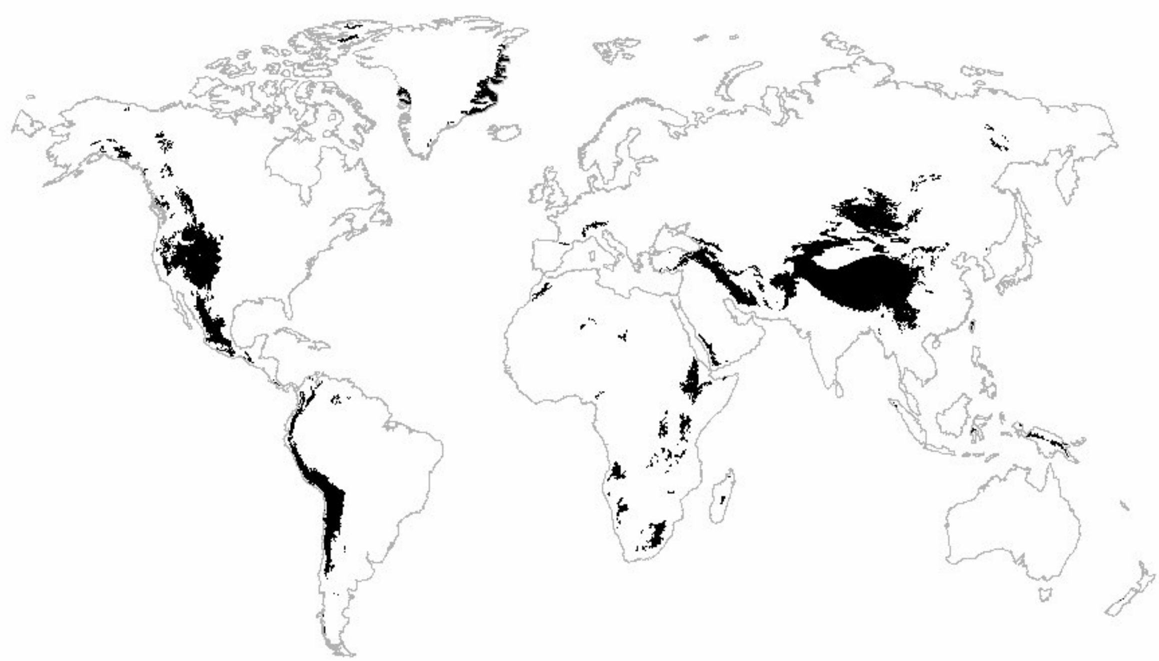
Savanna water resources are highly vulnerable to the effects of weed invasion, feral animals, overgrazing, and fire. Water resources are further strained by heavy water use in riparian areas for agriculture and tourism. (Douglas and Lukacs, 2004)

Water quality problems most commonly are caused by livestock and feral animals during the dry season.

3.2.9 Mountain Biome

As shown in Exhibit 3-20, the Mountain Biome includes the mountainous regions of North America and Europe, which include the Rocky Mountains in the western U.S. and the Alps in central Europe. The description in this section is representative of this biome throughout the world. Mountain Biomes are found at high altitudes and lie just below and above the snow line of a mountain. Existing inland sites in the Mountain Biome include Buckley AFB, Cheyenne Mountain AFB and Fort Carson Military Reserve, Colorado; and F.E. Warren AFB, Wyoming.

Exhibit 3-20. Global Distribution of the Mountain Biome



Source: Modified From National Geographic, 2003b

3.2.9.1 Air Quality

Given its high altitude, the Mountain Biome is characteristically cold with heavy snowfall and frequently bitter winds. Temperatures remain below freezing for at least seven months of the year, and in the summer, average temperatures range from 10°C to 15°C (50°F to 59°F). The average precipitation across mountain environments is 30 centimeters (12 inches) a year.

Mountain Biomes exhibit particular sensitivity to air pollution via deposition of both wet and dry pollutants, principally in snowpacks, which can in turn result in reduced surface water quality. Regional air pollutants of concern to mountainous areas include visibility-reducing PM, deposition of nitrogen and sulfur compounds, ozone, greenhouse gases that contribute to localized warming, and air toxics such as mercury and persistent organic pollutants.

Typical sources of air pollutants in the Mountain Biome include population centers, energy development and power plants, and agricultural activities.

3.2.9.2 Airspace

The U.S. Mountain Biome contains all FAA classifications for airspace, as described in Section 3.1.2.

3.2.9.3 Biological Resources

The high elevations of the mountain environments have harsh climatic conditions that support about 200 species of mountain plants.

Mountain animals have to tolerate cold temperatures and intense ultraviolet radiation. Because of the year-round cold, only warm-blooded animals can survive in the Mountain Biome, although insects also exist.

Some mammals within the Mountain Biome are considered sensitive species and may warrant special conservation measures, including critical habitat designation. Because food chains may be shorter in this biome than in more temperate biomes, food chains are more sensitive to environmental changes.

3.2.9.4 Geology and Soils

Much of the Mountain Biome appears as barren rock or a cover of thin soils. Soils in the biome are relatively fragile and are subject to erosion when disturbed.

The Mountain Biome is a complex network of mountain ranges characterized by extreme physiographic variability. Wide differences in elevation, slope steepness, and exposure exist locally and between major mountain masses.

Mountain Biomes are subject to numerous geological hazards, including earthquakes, landslides, and volcanoes.

3.2.9.5 Hazardous Materials and Hazardous Waste

Hazardous materials and hazardous waste attributes of the Mountain Biome are similar to those discussed in Section 3.2.1.5.

3.2.9.6 Health and Safety

Health and Safety attributes of the Mountain Biome are similar to those discussed in Section 3.2.1.6.

3.2.9.7 Noise

Sources of noise in the Mountain Biome are similar to principle sources of noise associated with sites where activities for the proposed BMDS may occur, as described in Section 3.2.1.7.

3.2.9.8 Transportation

The Mountain Biome sustains widespread infrastructure, including traffic circulation systems such as highways and byways, unpaved roads, non-maintained roads, trails, railroad lines, municipal, private, and military airports and any other system involved in mass transportation.

Due to the extreme cold and heavy snowfall characteristic of the Mountain Biome, airports within this region require the ability to provide landing access under zero visibility conditions such as blizzards and de-icing capability.

3.2.9.9 Water Resources

Surface water resources in the Mountain Biome include glacial lakes, streams, and rivers fed by rainfall and melting snow and those that originate from ground water sources. Mountain lakes are particularly sensitive to the effects of acidification because they have soft water, which does not neutralize acid readily.

In the Mountain Biome, elevated levels of contaminants accumulate in snowpacks, negatively impacting local flora and fauna. Upon melting, the concentrated pollutants are dispersed throughout the area watershed, deteriorating the quality of downstream surface and ground water systems. (USGS, 2003)

3.2.10 Broad Ocean Area

For purposes of this PEIS, the BOA encompasses the Pacific Ocean, the Atlantic Ocean, and the Indian Ocean.

Proposed activities in the BOA would take place at a distance of several hundred kilometers from any land mass. The BOA is subject to EO 12114, *Environmental Effects Abroad of Major Federal Actions,* which requires consideration of Federal actions abroad with the potential for impacts to the environment.

The Pacific Ocean is comprised of approximately 156 million square kilometers (60 million square miles) and includes the Bali Sea, Bering Sea, Bering Strait, Coral Sea, East China Sea, Flores Sea, Gulf of Alaska, Gulf of Tonkin, Java Sea, Philippine Sea, Savu Sea, Sea of Japan, Sea of Okhotsk, South China Sea, Tasman Sea, Timor Sea, and other tributary water bodies. Its maximum length is 14,500 kilometers (9,000 miles) and its greatest width is 17,700 kilometers (11,000 miles), which lies between the Isthmus of Panama and the Malay Peninsula. (Encyclopedia.com, 2003)

The Atlantic Ocean is comprised of approximately 76.8 million square kilometers (29.6 million square miles) and includes the Baltic Sea, Black Sea, Caribbean Sea, Davis Strait, Denmark Strait, part of the Drake Passage, Gulf of Mexico, Mediterranean Sea, North Sea, Norwegian Sea, almost all of the Scotia Sea, and other tributary water bodies. The Atlantic Ocean extends from the North Pole southward for about 16,100 kilometers (10,000 miles) to the Antarctic continent, and covers 106 million square kilometers (41 million square miles). The width of the Atlantic varies from approximately 2,850 kilometers (1,770 miles) between Brazil and Liberia to 4,830 kilometers (3,000 miles) between Norfolk, VA, and Gibraltar. The average depth is about 3,660 meters (12,000 feet) and the greatest depth is 8,650 meters (28,400 feet) in the Puerto Rico Trench. (Oceans of the World, 2003)

The Indian Ocean is comprised of about 68 million square kilometers (26 million square miles) and includes the Andaman Sea, Arabian Sea, Bay of Bengal, Great Australian Bight, Gulf of Aden, Gulf of Oman, Mozambique Channel, Persian Gulf, Red Sea, Strait of Malacca, Timor Sea, and other tributary water bodies. (CIA, 2003) It is triangular and bordered by Africa, Asia, Australia, and the Southern Ocean. Its maximum width is about 10,000 kilometers (6,200 miles) between the southernmost portions of Africa and Australia, and its average depth is approximately 4,000 meters (13,120 feet). The greatest depth occurs in the Java Trench at approximately 7,300 meters (24,000 feet) below sea level. (Oceans of the World, 2003)

3.2.10.1 Air Quality

No sources of ambient air quality monitoring data are known to exist for the BOA. There are no known existing emission sources in the Pacific Ocean. Air quality over the Pacific Ocean is expected to be good because there are no major sources of air pollution, and the nearly constant trade winds in the area serve to disperse any pollutants from transient sources, such as passing seagoing vessels or low-flying aircraft.

In the Atlantic Ocean, there is potential for large, thick plumes of aerosols blowing eastward over the North Atlantic. The aerosol plume is the regional haze produced by the industrial northeastern U.S. and typically occurs during the summer months. The haze is composed of sulfates and organics that originate from power plants and automotive sources. (NASA, 2003a) Ozone and other pollutants found in the Atlantic Ocean are primarily the result of anthropogenic sources.

A monitoring station in the Maldives Islands records air quality in the Indian Ocean. (Environmental News Network, 1999) The aerosol cloud covering much of the northern Indian Ocean originates primarily (at least 85 percent) from anthropogenic sources (Max Planck Society, 2001), namely agricultural and other biomass burning, the use of biofuels, and fossil fuel combustion in South and Southeast Asia. (Lelieveld et al., 2001) Model calculations indicate that, in contrast to European and North American pollution, anthropogenic emissions from South and East Asia reduce the concentration of hydroxyl (OH) radicals. Because OH is a powerful oxidant and acts as an atmospheric cleansing agent, the Asian pollution decreases the oxidizing power of the atmosphere, contributing to greater pollution problems over the Indian Ocean. (Max Planck Society, 2001)

Air quality over the Indian Ocean is seasonally poor due to anthropogenic emissions from growing South and Southeast Asian countries, particularly India. During the dry monsoon season (northern hemisphere winter), air pollutants in South and Southeast Asia are transported long distances to the Indian Ocean by persistent northeasterly monsoon winds. A dense, brown haze covers an area greater than 10 million square kilometers (3,900 million square miles) over most of the northern Indian Ocean (Max Planck Society, 2001), including the Arabian Sea, much of the Bay of Bengal, and part of the equatorial Indian Ocean to about five degrees south of the equator. (Environmental News Network, 1999) The haze extends from the ocean surface up to three kilometers (two miles). Comprised primarily of soot, sulfates, nitrates, organic particles, fly ash, and mineral dust, the airborne particles can reduce visibility over the BOA to less that 10 kilometers (6.2 miles) and reduce the solar heating of the ocean by about 15 percent. The haze also contains relatively high concentration of gases, including CO, SO_2, and other organic compounds. (Environmental News Network, 1999)

3.2.10.2 Airspace

Because the airspace in the BOA is beyond the territorial limit and is in international airspace, the procedures of the ICAO, outlined in ICAO Document 444, *Rules of the Air and Air Traffic Services* are followed. The FAA acts as the U.S. agent for aeronautical information to the ICAO.

Domestic Warning Areas are established in international airspace to contain activity that may be hazardous and to alert pilots of nonparticipating aircraft to the potential danger.

There are no airports or airfields located in the BOA.

High-altitude overseas jet routes cross the Pacific BOA via nine Control Area Extension corridors off the California coast.

3.2.10.3 Biological Resources

Marine biology of the open ocean consists of the animal and plant life that lives in and just above the surface waters of the sea and its fringes.

3.2.10.4 Geology and Soils

The Pacific Ocean floor of the central Pacific basin is relatively uniform, with a mean depth of about 4,270 meters (14,000 feet). (Oceans of the World, 2003) The Pacific Ocean is surrounded by a zone of violent volcanic and earthquake activity sometimes referred to as the "Pacific Ring of Fire." Icebergs are common in the Davis Strait, Denmark Strait, and the northwestern Atlantic Ocean from February to August and have been spotted as far south as Bermuda and the Madeira Islands. (Oceans of the World, 2003)

The principal feature of the bottom topography of the Atlantic BOA is a great submarine mountain range called the Mid-Atlantic Ridge. It extends from Iceland in the north to approximately 58 degrees south latitude, reaching a maximum width of about 1,600 kilometers (1,000 miles).

The Mid-Ocean Ridge dominates the terrain of the Indian Ocean floor. The Indian Ocean is subdivided by the Southeast Indian Ocean Ridge, Southwest Indian Ocean Ridge, and the Ninetyeast Ridge. (CIA, 2003)

Ocean sediments are composed of terrestrial, pelagic (open sea), and authigenic (grows in place with a rock) material. Terrestrial deposits consist of sand, mud, and rock particles formed by erosion, weathering, and volcanic activity on land and then washed to sea. (Wikipedia, 2003) Occasional icebergs occur in the southern reaches of the Indian Ocean. (CIA, 2003)

3.2.10.5 Hazardous Materials and Hazardous Waste

For test events using sea-based platforms, hazardous materials would be handled and used in accordance with all applicable state and Federal regulations as well as range-specific and U.S. Navy standard operating procedures.

The Clean Water Act prohibits the discharge of hazardous substances into or upon U.S. waters out to 370 kilometers (200 nautical miles). Also shipboard waste handling

procedures for commercial and U.S. Navy vessels govern the discharge of hazardous wastes as well as non-hazardous waste streams. These categories include “blackwater” (sewage); “greywater” (leftover cleaning water); oily wastes; garbage (plastics, non-plastics, and food-contaminated waste); hazardous wastes; and medical wastes. (U.S. Department of the Navy, 2002b)

The Uniform National Discharge Standards provisions of the Clean Water Act provide for the evaluation of the 39 discharges from U.S. Navy Vessels. Section 312(n)(2)(B) of the Clean Water Act identifies seven factors for consideration when determining if a discharge requires a marine pollution control device: the nature of the discharge; the environmental effects of the discharge; the effect that installing or using the marine pollution control device has on operations or the operational capability of the vessel; applicable Federal and state regulations; applicable international standards; and the economic costs of installing and using the marine pollution control device.

Under the regulations implementing the Act to Prevent Pollution from Ships, as amended, and the Marine Plastics Pollution Research and Control Act, the discharge of plastics, including synthetic ropes, fishing nets, plastic bags, and biodegradable plastics, into the water is prohibited. A slurry of sea water, paper, cardboard, or food waste that is capable of passing through a screen with opening no larger than 12 millimeters (0.4 inch) in diameter may not be discharged within 5.6 kilometers (three nautical miles) of land. Discharge of floating dunnage, lining, and packing materials is prohibited in navigable waters and in areas offshore less than 46.3 kilometers (25 nautical miles) from the nearest land.

Test event sponsors would be responsible for tracking hazardous wastes; for proper hazardous waste identification, storage, transportation, and disposal; and for implementing strategies to reduce the volume and toxicity of the hazardous waste generated. For test events using a sea-based platform, hazardous materials and hazardous waste would be managed in accordance with all applicable state and Federal regulations as well as Range-specific and U.S. Navy standard operating procedures.

The transport, receipt, storage, and handling of hazardous materials would comply with Army TM 38-410, Navy NAVSUP PUB 505, Air Force AFR 69-9, Marine Corps MCO 4450-12 or Defense Logistics Agency DLAM 4145.11, Storage and Handling and Implementing Regulations Governing Storage and Handling of Hazardous Materials.

3.2.10.6 Health and Safety

The region of influence for health and safety in the BOA would be limited to work crews located on sea-based platforms. The WorldWide Navigational Warning Service is a worldwide radio and satellite broadcast system for the dissemination of Maritime Safety Information to U.S. Navy and merchant ships. The WorldWide Navigational Warning

Service provides timely and accurate long range and coastal warning messages promoting the safety of life and property at sea and Special Warnings that inform mariners of potential political or military hazards that may affect safety of U.S. shipping.

3.2.10.7 Noise

Studies of ambient noise of the ocean have found that the sea surface is the predominant source of noise above the water, and that the source is associated with the breaking of waves. (Knudsen, et al., 1948, as referenced in FAA, 2001a) The primary human-made noise source within the BOA is associated with ship and vessel traffic, including transiting commercial tankers and container ships, commercial fishing boats, and military surface vessels and aircraft. Noise sources above the water would also include launch or other activities from sea-based platforms.

Noise also occurs under the ocean surface. The dominant sources of ambient underwater noise and their corresponding frequency ranges are seismic activity, turbulent-pressure fluctuations, and second order pressure effects due to surface gravity waves (1to 100 Hz); ship traffic and industrial activity (10 Hz to 10 kHz); biologics (10 Hz to 100 kHz); sea ice activity (10 Hz to 10kHz); breaking waves, bubbles, and spray (100 Hz to 20 kHz); precipitation (100 Hz to 30 kHz); and thermal effects (30 to 100 kHz). Noise from sources above the water may be magnified underwater. For example, a tug and barge produces sound that measures 171 dB in water and 110 dB in air. (Gisiner, 1998)

3.2.10.8 Transportation

The Transportation in the BOA consists predominantly of marine shipping. Marine shipping refers to the conveyance of freight, commodities, and passengers via mercantile vessels.

3.2.10.9 Water Resources

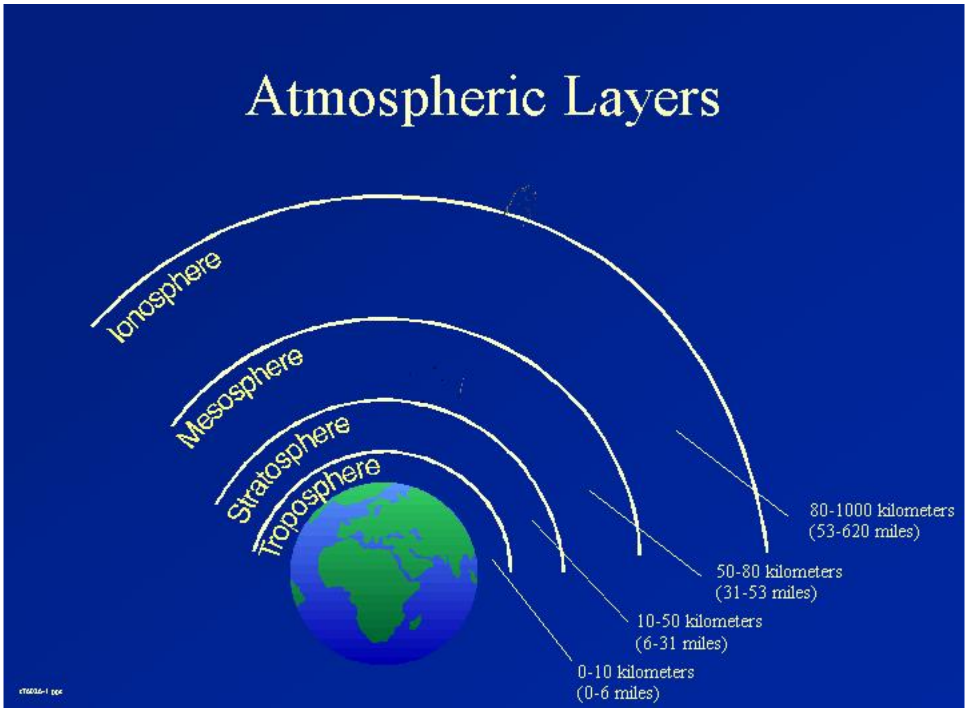
The two main factors that define ocean water are the temperature and the salinity of the water. (UCAR, 2001b) Water quality in the open ocean is considered excellent, with high water clarity, low concentrations of suspended matter, dissolved oxygen concentrations at or near saturation, and low concentrations of contaminants such as trace metals and hydrocarbons

3.2.11 Atmosphere

The Atmosphere Environment refers to the Atmosphere that envelops all areas of the Earth and consists of the four principal layers of the Earth's atmosphere: troposphere,

stratosphere, mesosphere, and ionosphere or thermosphere.[50] These layers are characterized by altitude, temperature, structure, density, composition, and degree of ionization – the positive or negative electric charge associated with each layer. Altitude ranges for atmospheric layers are described in Exhibit 3-21.

Exhibit 3-21. Altitude Range for Atmospheric Layers



Source: ICF Kaiser for Beal Aerospace, 1998

3.2.11.1 Air Quality

During the past 150 years, combustion of fossil fuels has resulted in increasing concentrations of atmospheric gases that are believed to influence global climate. The temperature of the Earth's atmosphere is determined by three factors: the sunlight it receives, the sunlight it reflects, and the infrared radiation absorbed by the atmosphere. The principal absorbers include CO_2, water vapor, nitrous oxide, chlorofluorocarbons (CFCs), and methane.

3.2.11.2 Airspace

Exhibit 3-22 illustrates the relationship between airspace classifications and atmospheric layers.

[50] Most resource areas do not apply to the Atmosphere. Therefore, the Affected Environment discussion includes only Air Quality, Airspace, and Biological Resources, and consideration of Orbital Debris.

Exhibit 3-22. Relationship Between Airspace Classifications and Atmospheric Layers

Type of Airspace	Altitude (from MSL)	Atmospheric Layer(s)
Controlled	> 5.5 kilometers (3.4 miles)	Troposphere, Stratosphere
Uncontrolled	< 4.4 kilometers (2.7 miles)	Troposphere

3.2.11.3 Biological Resources

While the atmosphere generally is not considered to contain biological resources, atmospheric conditions have a direct impact on climate, which affects the location and health of biological resources.

3.2.11.4 Orbital Debris

Although there is no absolute definition of space, it can generally be defined at an altitude approximately 100 kilometers (62 miles) from the Earth's surface, where the aerodynamic forces of the thinning atmosphere become so small that the various control surfaces of an aircraft (e.g., rudder, aileron, and elevator) cease to function effectively. Space is not generally considered to be part of the human environment, as defined by NEPA and therefore, the discussion of impacts to space for this PEIS will be limited to the impacts from orbital debris. Orbital debris is man-made material introduced by spacecraft. The debris can be as large as spent rocket motors and as small as dust particles released during motor firings. Orbital debris that remains on orbit could create hazards to orbiting spacecraft, to astronauts or cosmonauts engaged in extra-vehicular space activities and it could have impacts upon reentry if the debris reaches the Earth's surface in large pieces or contains hazardous components. The effects of orbital debris on other spacecraft depend on the altitude, orbit, velocity, angle of impact, and mass of the debris. Eventually this orbiting debris loses energy and drops into consecutively lower orbits until it reenters Earth's atmosphere. Orbital debris has no impact on the human environment unless and until the debris enters the Earth's atmosphere. De-orbiting debris (i.e., debris reentering the atmosphere from orbit) is a potential concern as a course of deposition of small particles into the stratosphere, and a possible contributor to stratospheric ozone depletion.

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4 ENVIRONMENTAL CONSEQUENCES

Introduction

This Section of the PEIS describes the potential environmental consequences of implementing the proposed action via Alternatives 1 and 2 in various worldwide biomes, the BOA or the atmosphere. This Section also identifies potential cumulative impacts associated with those alternatives. It is intended to address the impacts in the context of worldwide biomes based on similar ecological characteristics rather than political boundaries. Only BMDS Programs and activities that are considered reasonably foreseeable are analyzed in this PEIS. Programs that are still conceptual in nature are not analyzed in this document.

This PEIS provides a comprehensive, global analytical framework that can support subsequent analysis of specific actions at specific locations, as appropriate. A description of the analytical framework follows in the next section. The manner and extent to which future actions tier from the PEIS is left to the discretion of the preparer. The framework established in this document is intended to serve as a guide for preparing future site-specific documents and does not dictate their preparation.

This PEIS also contemplates BMDS activities outside the jurisdictional limits of the U.S. and therefore beyond the scope of NEPA and other Federal U.S. laws. The DoD addresses these issues primarily in DoD Directive 6050.7 and DoD Instruction 4715.5. See Appendix G for a description of the framework to be used for this process.

Cumulative impacts of Alternatives 1 and 2 are also considered. The CEQ NEPA regulations define cumulative impacts as the impacts on the environment that result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions (40 CFR § 1508.7).

Cumulative impacts can result from individually minor, but collectively significant, actions taking place over a period of time. For this PEIS, potential cumulative impacts are addressed for activities that would occur on a scale similar to the proposed BMDS. Thus, activities were considered that are national or international in scope. Future activities were identified based on review of worldwide rocket launches and commercial and government space programs.

As a result of the public comment process, additional areas of analysis – orbital debris, perchlorate, and radar impacts on wildlife – have been addressed in more technical detail in Appendices L, M, and N, respectively.

Analysis Process

Because of the extensive nature of this project, this PEIS analyzes the BMDS as described in the following four steps.

- **Step 1 – Identify and Characterize Activities** for each BMDS component.
- **Step 2 – Identify Activities with No Potential for Impact** and dismiss those for which prior NEPA analysis determined insignificant impacts or those that are categorically excluded.
- **Step 3 – Identify Similar Activities across Life Cycle Phases** for activities that are determined to have similar environmental impacts.
- **Step 4 – Conduct Environmental Analyses** for the remaining life cycle activities for each component.

Step 1 – Identify and Characterize Activities

The BMDS is organized by component (i.e., weapons; sensors; C2BMC; and support assets). Each component has life cycle activities associated with developing, testing, deploying, and decommissioning those components within the BMDS. These activities produce environmental impacts which are examined in this PEIS.

To consider impacts of the BMDS, the emissions/stressors from the component life cycle activities were identified and characterized. Exhibit 1-3 displays the typical activities within each life cycle phase for each component.

Step 2 – Identify Activities with No Potential for Impact

Actions for which previous NEPA analyses indicated no significant impacts[51] or actions that are normally categorically excluded[52] were not analyzed in detail in this PEIS. Exhibit 4-1 identifies activities for which categorical exclusions are generally available. These activities are not further analyzed in this PEIS.

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[51]After scrutinizing NEPA documents for programs and elements (see Appendix D), it was determined that there was no significant impact from several BMDS life cycle activities because these activities have been previously analyzed and were shown to have no impact.

[52] In accordance with CEQ regulations for implementing NEPA (40 CFR 1507.3(b)), the DoD and military services have developed regulations that provide for the establishment of categorical exclusions (40 CFR 1507.3(b)) for those actions, which do not individually or cumulatively have a significant impact on the human environment. Where appropriate, DoD and military services have established categorical exclusions for such activities. For example, infrequent, temporary (less than 30 days) increases in air operations up to 50 percent of the typical installation aircraft operation rate are categorically excluded. See Appendix G, Exhibit G-1 for citations of DoD NEPA implementing regulations categorical exclusions.

Exhibit 4-1. Life Cycle Activities Determined to Have No Significant Environmental Impact

Life Cycle Phase	Activities
Development	Planning/Budgeting
	Research and Development
	Systems Engineering
	Tabletop Exercises
Deployment	Training

Some activities such as transportation of components, maintenance and sustainment, and manufacturing were determined to need no further analysis in this PEIS either because they have been categorically excluded or addressed in previous NEPA analyses and found to have no significant impacts. The rationale for these conclusions is presented in Sections 4.1.1.8, 4.1.1.9, and 4.1.1.10, respectively, of this PEIS.

Step 3 – Identify Similar Activities across Life Cycle Phases

The remaining activities with the potential for environmental impacts were then examined to determine which had similar environmental impacts. For example, impacts associated with site preparation and construction in the development phase would be similar to or the same as impacts from site preparation and construction activities in the testing and deployment phases of the life cycle. Accordingly many activities were addressed together to eliminate redundancy.

Many activities in the various life cycle phases have been combined in the analysis of Support Assets. This was done because activities associated with support assets whether infrastructure, equipment or test assets (including countermeasures and simulants), were considered similar in terms of impacts created. Some activities require the use of operating platforms, such as aircraft for air-based components or ships for sea-based components; these specific platforms are considered support assets. Impacts from the use of operating platforms are discussed as part of Support Assets. Details of the life cycle phase analysis are provided below (Life Cycle Phase Activities). Exhibits 4-2 through 4-5 illustrate by life cycle phase, the activities that are analyzed in this PEIS and the corresponding section in which the analysis can be found.

Step 4 – Conduct Environmental Analyses

The significance of an impact that an activity has on the environment is a function of the nature of the receiving environment. For example, a booster launch has different emissions than those from activating a chemical laser. Whether those emissions create

impacts and the degree of significance of these impacts depends upon the environment in which they are released.

In this analysis, the PEIS considers the emissions/stressors from each component's activity in the context of each resource area (e.g., air, water, etc.). Impacts were distinguished based on the different operating environments (land, sea and air for Alternative 1 and land, sea, air and space for Alternative 2) in which the activity would occur. These impacts were further distinguished based on the worldwide biomes in which the activity would occur.

As a result, the PEIS is organized by component; the analysis examines each resource area and distinguishes between operating environments in the context of a particular biome. The analysis also describes where the impacts differ based on the operating environment or biome.

Life Cycle Phase Activities

Development Phase Activities

Exhibit 4-2 shows the activities in the development life cycle phase that were considered to produce environmental impacts and where in the analysis each activity is addressed. Planning and budgeting; research and development; systems engineering; and tabletop exercises are activities for which categorical exclusions are generally available; therefore these activities are not further analyzed in this PEIS. Manufacturing of prototypes and maintenance and sustainment are routine activities that have been considered in previous NEPA analyses and determined to have no significant impact or are categorically excluded and are not considered further in this PEIS. Site preparation and construction and testing are part of other life cycle phases for the proposed BMDS. To eliminate redundancy these activities are addressed together. Testing of component prototypes has been assumed to cause the same or similar impacts as testing of component as described for the test life cycle phase.

Exhibit 4-2. Analysis of Impacts of Development Phase Activities

Activity	Source of Impact	Impacts Analysis
Planning/Budgeting	None	Routine activity categorically excluded; not further analyzed
Research and Development	None	Routine activity categorically excluded; not further analyzed
Systems Engineering	None	Routine activity categorically excluded; not further analyzed

Exhibit 4-2. Analysis of Impacts of Development Phase Activities

Activity	Source of Impact	Impacts Analysis
Site Preparation and Construction	Construction or modifications necessary to support component prototype development	Section 4.1.1.9 Support Assets - Infrastructure
Maintenance or Sustainment	Activities related to hardware or software upgrades or maintenance of component prototypes	Routine activity categorically excluded or analyzed in previous NEPA documents and found to have no significant impact. Rationale presented in Section 4.1.1.9 Support Assets - Infrastructure
Manufacturing of Prototypes	Manufacturing of component prototypes	Routine activity categorically excluded or analyzed in previous NEPA documents and found to have no significant impact. Rationale presented in Section 4.1.1.10 Support Assets - Test Assets
Testing of Component Prototypes	Activities related to activation or use of the component prototypes	Sections 4.1.1.1 Weapons - Lasers, 4.1.1.2 Weapons - Interceptors, 4.1.1.3 Sensors - Radar, 4.1.1.4 Sensors - Infrared and Optical, 4.1.1.5 Sensors - Laser, 4.1.1.6 C2BMC - Computer Terminals and Antennas, 4.1.1.7 C2BMC - Underground Cable, 4.1.1.8 Support Assets - Equipment, 4.1.1.9 Support Assets - Infrastructure, 4.1.1.10 Support Assets - Test Assets
Tabletop Exercises	None	Routine activity categorically excluded; activity not further analyzed

Test Phase Activities

Test life cycle phase activities were considered in two distinct analyses; one focused on the components and their individual test activities, and the other focused on System Integration Testing which could include multiple components with one or more attempted intercepts to test system capability and effectiveness in increasingly robust and realistic test scenarios.

BMDS *component testing activities* assumed to have potential impacts on the environment were considered for each component as shown in Exhibit 4-3. Some of the activities that comprise the test life cycle phase are unique to individual components. For example launch/flight is relevant for interceptors and targets but not for C2BMC. Test life cycle phase activities are specific to each component. Therefore, Exhibit 4-3 is presented by component and shows those specific activities that were determined to have the potential for impact. Other activities such as site preparation and construction are not unique to individual components and are therefore considered collectively in Support Assets. The impacts associated with a target intercept involving either laser or interceptor weapons are addressed as part of Test Integration.

Exhibit 4-3. Analysis of Impacts of Test Life Cycle Phase Activities

Component	Activity	Source of Impact	Impacts Analysis
Weapons-Laser	Manufacturing of Test Articles	Manufacturing/assembly of laser components and chemicals	Routine activity categorically excluded or analyzed in previous NEPA documents and found to have no significant impact. Rationale presented in Section 4.1.1.10 Support Assets - Test Assets
	Site Preparation and Construction	Construction or modifications necessary to support laser use/firing	Section 4.1.1.9 Support Assets - Infrastructure

Exhibit 4-3. Analysis of Impacts of Test Life Cycle Phase Activities

Component	Activity	Source of Impact	Impacts Analysis
	Transportation	Transport of the laser and chemicals to appropriate location	Routine activity categorically excluded or analyzed in previous NEPA documents and found to have no significant impact. Rationale presented in Section 4.1.1.8 Support Assets - Equipment
	Activation	Firing the laser	Section 4.1.1.1 Weapons - Lasers
Weapons-Interceptor	Manufacturing of Test Articles	Manufacturing interceptor components and propellants	Routine activity categorically excluded or analyzed in previous NEPA documents and found to have no significant impact. Rationale presented in Section 4.1.1.10 Support Assets - Test Assets
	Site Preparation and Construction	Construction or modifications necessary to support launch	Section 4.1.1.9 Support Assets - Infrastructure
	Transportation	Transport of the booster, kill vehicle, and propellants to the launch location	Routine activity categorically excluded or analyzed in previous NEPA documents and found to have no significant impact. Rationale presented in Section 4.1.1.8 Support Assets - Equipment
	Prelaunch	Assembly and fueling of the booster or kill vehicle, as appropriate	Section 4.1.1.2 Weapons - Interceptors

Exhibit 4-3. Analysis of Impacts of Test Life Cycle Phase Activities

Component	Activity	Source of Impact	Impacts Analysis
	Launch/Flight	Ignition of rocket motors and flight of boosters or separation of kill vehicle and subsequent flight along its trajectory	Section 4.1.1.2 Weapons - Interceptors
	Postlaunch	Clean up or debris recovery, if required	Section 4.1.1.2 Weapons - Interceptors
Sensors	Manufacturing	Manufacturing/assembly of the sensor hardware and software	Routine activity categorically excluded or analyzed in previous NEPA documents and found to have no significant impact. Rationale presented in Section 4.1.1.10 Support Assets - Test Assets
	Site Preparation and Construction	Construction or modifications necessary to support sensor use	Section 4.1.1.9 Support Assets - Infrastructure
	Transportation	Transport of the sensor to appropriate location	Routine activity categorically excluded or analyzed in previous NEPA documents and found to have no significant impact. Rationale presented in Section 4.1.1.8 Support Assets - Equipment
	Activation	Use of the sensor	Sections 4.1.1.3 Sensors - Radar, 4.1.1.4 Sensors - Infrared and Optical, and 4.1.1.5 Sensors - Laser

Exhibit 4-3. Analysis of Impacts of Test Life Cycle Phase Activities

Component	Activity	Source of Impact	Impacts Analysis
C2BMC	Manufacturing	Assembly of associated hardware and software	Routine activity categorically excluded or analyzed in previous NEPA documents and found to have no significant impact. Rationale presented in Section 4.1.1.10 Support Assets - Test Assets
	Site Preparation and Construction	Construction or modification for computer terminals, antennas, and underground cable trenching	Section 4.1.1.9 Support Assets - Infrastructure
	Transportation	Transport of C2BMC to appropriate location	Routine activity categorically excluded or analyzed in previous NEPA documents and found to have no significant impact. Rationale presented in Section 4.1.1.8 Support Assets - Equipment
	Activation	Use of computer terminals, antennas, and underground cable	Sections 4.1.1.6 C2BMC - Computer Terminal and Antennas, 4.1.1.7 C2BMC - Underground Cable

Exhibit 4-3. Analysis of Impacts of Test Life Cycle Phase Activities

Component	Activity	Source of Impact	Impacts Analysis
Support Assets-Support Equipment	Manufacturing	New or major modification of existing support equipment	Routine activity categorically excluded or analyzed in previous NEPA documents and found to have no significant impact. Rationale presented in Section 4.1.1.10 Support Assets - Test Assets
	Operational Changes	Implementation of new operating parameters of existing support equipment	Section 4.1.1.8 Support Assets - Equipment
	Site Preparation and Construction	New construction or major modification of existing infrastructure	Section 4.1.1.9 Support Assets - Infrastructure
	Transportation	Transport of support equipment	Routine activity categorically excluded or analyzed in previous NEPA documents and found to have no significant impact. Rationale presented in Section 4.1.1.8 Support Assets - Equipment
Support Assets-Infrastructure	Site Preparation and Construction	Construction or modification of infrastructure	Section 4.1.1.9 Support Assets - Infrastructure

Exhibit 4-3. Analysis of Impacts of Test Life Cycle Phase Activities

Component	Activity	Source of Impact	Impacts Analysis
Support Assets- Test Assets	Manufacturing	Assembly of hardware/software associated with the test sensor	Routine activity categorically excluded or analyzed in previous NEPA documents and found to have no significant impact. Rationale presented in Section 4.1.1.10 Support Assets - Test Assets
	Site Preparation and Construction	Construction or modifications necessary to support the test sensor or launch	Section 4.1.1.9 Support Assets - Infrastructure
	Transportation	Transport of the sensor, booster and propellants to the test location	Routine activity categorically excluded or analyzed in previous NEPA documents and found to have no significant impact. Rationale presented in Section 4.1.1.8 Support Assets - Equipment
	Activation	Use of the test sensor in a test event	Section 4.1.1.3 Sensors - Radar, 4.1.1.4 Sensors - Infrared and Optical, and 4.1.1.5 Sensors - Laser
	Prelaunch	Assembly and fueling of the booster as appropriate	Section 4.1.1.2 Weapons - Interceptors

Exhibit 4-3. Analysis of Impacts of Test Life Cycle Phase Activities

Component	Activity	Source of Impact	Impacts Analysis
	Launch/Flight	Ignition of rocket motors, separation from launch platform, and flight of the boosters or separation of the target object and subsequent flight along its trajectory	Section 4.1.1.2 Weapons - Interceptors
	Use of Countermeasures, Simulants or Drones	Use and deployment of various countermeasures, simulants or drones to support testing	Section 4.1.1.10 Support Assets - Test Assets
	Postlaunch	Clean up or debris recovery to include launch platform, countermeasures, and simulants, if required	Section 4.1.1.2 Weapons - Interceptors

The operating environments in which test activities occur (i.e., land, sea, air, and space) were determined to influence the environmental impacts only for laser activation, launch/flight activities, sensor activation, and activation of C2BMC. Therefore, these activities were also considered by operating environment in analyzing their environmental effects. Individual component tests are needed to demonstrate the functionality of BMDS technology. Potential environmental consequences of component tests are discussed in previous NEPA documentation and in their respective sections in this PEIS.

BMDS *System Integration Testing activities* would occur at the system level. System Integration Tests evaluate the ability of various component configurations to work together. System Integration Testing would be used to assess the ability of BMDS components to work interoperably and to meet the required functional capabilities of the BMDS as a system and to demonstrate performance.

System Integration Tests would integrate existing and planned components such as sensors, weapons, and C2BMC. This PEIS assesses the potential for environmental impacts of integrated BMDS testing activities under Alternatives 1 and 2. Test integration activities would involve land-, sea-, and air-based operating environments for weapons; and land-, sea-, air- and space-based operating environments for sensors, C2BMC, and support assets for Alternative 1. Assessment of Alternative 2 considers

only the additional impacts of proposed space-based operating environment for interceptors.

System level tests would include modeling, simulation, and analysis; integrated missile defense wargames; MDIE; integrated GTs; and SIFTs. A description of each type of test is provided in Exhibit 2-22.

The analysis of intercept impacts includes discussion of the impact of debris from an intercept. Depending on the location used for testing or deployment of weapons, debris may impact either inland or in marine environments. Therefore, impacts from postlaunch activities involving intercepts have been subcategorized based on where intercept debris would be likely to impact. For purposes of this PEIS, it was assumed that the debris impacts from any single intercept would occur within a single receiving environment, either on land or in water.

Deployment Phase Activities

Deployment phase activities with the potential for impacts on the environment would include manufacturing (production) of components, site preparation and construction, use of human services, transportation of components to the deployment site, testing (prelaunch, launch/flight, activation, postlaunch), training, and maintenance or sustainment of the components (operation and maintenance, upgrades, and service life extension). The environmental impacts associated with maintenance including hardware and software upgrades and service life extension are routine activities that are generally categorically excluded and are not analyzed in this PEIS. The environmental impacts associated with manufacturing, site preparation and construction, and transportation, and human services are routine activities that are generally categorically excluded or are analyzed in previous NEPA documents and found to have no significant impact. The rationale for why they are not analyzed in this PEIS is provided in Support Assets. The environmental impacts associated with training would be similar to the use of the component as described under the testing life cycle activity.

Future deployment of BMDS components would occur at times and places where the deployed component would provide the most useful defensive capability to counter existing or emerging threats. This could include sites outside the continental U.S. The environmental impacts of deployment at specific locations would need to be considered in subsequent site-specific NEPA analyses tiered from this PEIS. The activities and associated impacts from deployment phase activities are presented in Exhibit 4-4.

Exhibit 4-4. Analysis of Impacts of Deployment Phase Life Cycle Activities

Activity	Source of Impact	Impacts Analysis
Manufacturing	Manufacturing (production) of the component	Routine activity categorically excluded or analyzed in previous NEPA documents and found to have no significant impact. Rationale presented in Section 4.1.1.10 Support Assets - Test Assets
Site Preparation and Construction	Construction or modifications necessary to support component deployment	Section 4.1.1.9 Support - Infrastructure
Transportation	Transporting component to deployment location	Routine activity categorically excluded or analyzed in previous NEPA documents and found to have no significant impact. Rationale presented in Section 4.1.1.8 Support Assets – Equipment
Testing	Activities related to prelaunch, launch/flight, postlaunch, or activation of the component	Testing of components would be the same as or similar to the use of the component as described under the testing lifecycle activity
Maintenance or Sustainment	Activities related to hardware or software upgrades	Activities related to prelaunch, launch/flight, postlaunch, or activation of the component
Upgrades	No source of impact	Routine activity categorically excluded; activity not further analyzed
Training	Activities related to prelaunch, launch/flight, postlaunch, or activation of the component	Testing of components would be the same as or similar to the use of the component as described under the testing life cycle activity
Use of Human Services	Activities related to increasing the presence of staff at deployment sites	The use of human services is more appropriately addressed in site specific documentation. Rationale presented in Section 4.1.1.9 Support Assets - Infrastructure

Exhibit 4-4. Analysis of Impacts of Deployment Phase Life Cycle Activities

Activity	Source of Impact	Impacts Analysis
Service Life Extension	No source of impact	Routine activity categorically excluded; activity not further analyzed

Decommissioning Phase Activities

Typical decommissioning phase activities would include demilitarization and disposal or replacement of the component. Activities associated with decommissioning may include recycling and disposal of hazardous materials. The activities associated with decommissioning are presented in Exhibit 4-5. The environmental impacts associated with decommissioning of specific components would be more appropriately addressed in subsequent tiered environmental analyses.

Exhibit 4-5. Analysis of Impacts of Decommissioning Phase Life Cycle Activities

Activity	Source of Impact	Impacts Analysis
Demilitarization	Destruction of offensive or defensive systems capability which may include disposal or detonation of hazardous materials (propellants, batteries, etc)	A roadmap for considering decommissioning impacts is provided; an analysis would be more appropriately addressed in subsequent tiered environmental analyses.
Disposal	Materials to be disposed may include hazardous materials and hazardous waste (propellants, coolants, batteries, etc.)	A roadmap for considering decommissioning impacts is provided; an analysis would be more appropriately addressed in subsequent tiered environmental analyses.

A roadmap for considering impacts of decommissioning for each component has been developed and is provided below. A Government depot or contractor may accomplish demilitarization and disposal of the components. The military service responsible for managing each piece of equipment would initiate the demilitarization and disposal process. Normally, each individual piece of equipment would have disposition instructions that have been prepared by its development contractor or project office in the case of MDA. These instructions identify the hazardous materials contained in the equipment item. A copy of the disposition instructions would be provided to the depot or contractor performing the demilitarization and disposal. It would be the responsibility of the depot or contractor to identify, remove, segregate, package, and document all hazardous materials in the item. In the case of a depot, disposal of hazardous materials

would be through Government channels as described below. When a contractor is utilized, hazardous materials disposal would be processed through commercial channels in compliance with all applicable Federal, state, and local laws.

When a depot performs the demilitarization and disposal functions, disposal of hazardous and nonhazardous materials would be through a Defense Reutilization and Marketing Office (DRMO). The DRMO would physically accept and process all property that falls within the DRMO area of responsibility. The DRMO would be responsible for disposing of hazardous materials in accordance with applicable Federal, state, and local laws, utilizing best management practices.

Components would be transported to demilitarization and disposal locations by the method appropriate to their location and military sensitivity. Transportation to contiguous land areas could be by ground (truck or rail) in accordance with DOT, state and local transportation and safety regulations and procedures. Transportation from, or to, island locations would be by aircraft in accordance with DOT and U.S. Air Force regulations and procedures, or by U.S. Navy, U.S. Army, or commercial ships in accordance with U.S. Coast Guard and Maritime Administration requirements and any other applicable regulations and procedures.

Potential decommissioning activities for weapons, sensors, C2BMC, and support assets are discussed below.

Decommissioning of ***weapons*** components would involve transferring the equipment to other uses, as described above, or demilitarization in accordance with the requirements of DoD 4160.21-M-1, Appendix 4 "*Demilitarization Requirements for Munitions List Items*." Specific requirements are found in DoD 4160.21-M-1, Appendix 4, Category IV, "*Launch Vehicles, Guided Missiles, Ballistic Missiles, Rockets, Torpedoes, and Components*," and DoD 4160.21-M-1, Appendix 4, Category V "*Military Explosives, Solid and Liquid Propellants, Bombs, Mines, Incendiary Agents, and Their Constituents*." Because the BMDS does not include nuclear weapons, the requirements of DoD 4160.21-M-1, Appendix 4, Category XVI, "*Nuclear Weapons Design and Test Equipment*," would not apply to the decommissioning of weapons components. Examples of potential decommissioning plans for missiles (interceptors and targets) are included below.

Decommissioning of missiles would first require the removal and proper disposal of liquid, solid, or hybrid (liquid and solid combination) propellants from the booster(s). Where possible, propellants would be recovered and reused. Aging motors that contain flaws would likely be decommissioned using open detonation. Some liquid fueled missiles are fueled only before a scheduled launch; others are pre-fueled. In addition, the kill vehicle on an interceptor missile typically uses liquid hypergolic propellants and some solid propellants for its divert and attitude control system. Liquid propellants would need to be emptied before disassembly of the missile could occur. Solid rocket

propellant would be removed for reclamation or burning in a controlled environment, such as an incinerator. Where practicable, incineration or closed burning of rocket propellant would be performed. Most of the acid and particulates ejected during the burn would be collected in plume scrubber water. This water would be treated for acceptance by a publicly owned (or federally owned) water treatment works or discharged in accordance with a National Pollutant Discharge Elimination System (NPDES) permit.

Decommissioning of lasers would require the removal and proper disposal or neutralization of chemical laser fuels from the storage facilities. Where possible, these chemicals would be recovered and reused. Decommissioning of the aircraft would be conducted in accordance with DOD 4160.21-M-1, Appendix 4, Category III, "*Military Aircraft (Combat, Tactical Air Vehicles) Spacecraft and Associated Equipment*" and other applicable requirements. Decommissioning activities for other laser components would be conducted as appropriate in accordance with applicable regulations.

The MDA would develop new ***sensor*** equipment in addition to using a variety of existing equipment. Equipment intended only for testing purposes and not for use in the BMDS architecture would be returned to the responsible military service for continuation of its original duties. Any decommissioning activities for this equipment would be carried out by the responsible military service. Equipment would be demilitarized in accordance with DoD 4160.21-M-1, Appendix 4, Category XII "*Fire Control, Range Finder, Optical, and Guidance and Control Equipment.*"

The decommissioning of sensors, equipment, and facilities would include the recycling/reuse or disposal of residual materials and unused products associated with the antennae, electronic, cooling, and power units. These products would include but are not limited to lubricants, coolants, batteries, and fuels. These materials would be decommissioned in accordance with Chapter 10, Environmentally Regulated and Hazardous Property, of the (DoD) Directive 4160.21-M, *Defense Reutilization and Disposal* and any applicable Federal, state, and local regulations and requirements. Reusable materials from sensors, such as metals, would be recovered. Other materials would be shredded and recycled or disposed of, as appropriate.

Sea-based sensors such as the SBX radar use a MOSS CS50 platform to support a radar support structure and radome. The CS50 platform was designed for use in oil exploration. After the sea-based radar system is removed, the platform could be converted to another MDA use (launch platform, test or deployed radar platform, etc.), transferred to a military service, or sold. If another use of the platform is not feasible, DoD would dismantle the platform and dispose of the materials by recycling, reuse, or discarding it in appropriate waste management facilities. DoD could also consider sinking the platform at sea after all toxic materials are removed, to provide a foundation for marine life.

Space-based sensors would be decommissioned by being abandoned in orbit, parked in a higher orbit, deorbited, or retrieved. Space-based sensors left in orbit that have non-BMDS utility could be transferred to alternate uses if economically feasible and the alternate use would not affect national security. Potential alternate uses include monitoring rocket launches and aircraft flights. DoD would make decisions on the disposition of the space-based components based on the stability of their orbits, the costs and risks of deorbiting or retrieval, the remaining useful life of the equipment, and potential for alternate uses.

Components could be retrieved from orbit and brought back to Earth for decommissioning and demilitarization if allowing them to remain in orbit poses unacceptable risks. Components abandoned in orbit would continue to orbit until gravitational and atmospheric drag cause the component to deorbit and reenter the atmosphere where it would either burn up or fall to Earth. Potential risks include danger to populations on Earth or the loss of equipment sensitive to national security. U.S. Space Command tracks orbits of satellites and space debris, and provides reentry predictions. When the predictions indicate a risk to land areas, a controlled deorbit would be considered to ensure reentry occurs over ocean areas. Parking the component in a higher orbit would increase the time before deorbit. Demilitarization of space-based components would be conducted in accordance with DoD 4160.21-M-1, Appendix 4, Category VIII, "*Military Aircraft (Combat, Tactical Air Vehicles), Spacecraft and Associated Equipment*," Category XI, "*Military and Space Electronics,*" and Category XV, "*Spacecraft Systems and Associated Equipment.*"

The MDA would develop new ***C2BMC*** equipment as well as use a variety of existing equipment. As technology advances and the needs of the BMDS evolve, multiple upgrades of C2BMC hardware and software are likely. DoD would be responsible for decommissioning activities in accordance with appropriate requirements for the specific C2BMC equipment.

Support assets include fixed facilities and mobile equipment as well as test assets including the test bed, test sensors, and targets. This discussion of decommissioning activities focuses on fixed and mobile equipment. Components that make up the test bed, test sensors and targets are addressed previously under decommissioning weapons and sensors.

Fixed facilities may include DoD-owned buildings located on ranges, installations, or related real estate such as islands temporarily used for BMDS purposes. Government contractor facilities include such sites as the Nevada Test Site and Sandia National Laboratory in New Mexico. Privately owned facilities include those owned by companies manufacturing components for the BMDS. Exhibit 4-6 describes decommissioning activities for fixed facilities.

Exhibit 4-6. Decommissioning Activities for Fixed Facilities

Fixed Facilities		*Decommissioning Activities*			
		Left in Place			**Disposed**
		Mission Realignment	Return to Owners/Host Facility	Transfer Title to New Owner	Transfer Land Title to New Owner
Buildings	DoD-owned	X		X	X
	Government Contractor		X		
	Private		X		
Launch Locations	DoD Launch Pads/Runways	X		X	X
	Silos	X			
	Other Government		X		
	Private		X		
	Municipal Airports (runways)		X		
Utilities	Water/Sewer Systems	X	X	X	X
	Power Plants (gas and coal fired)	X	X	X	X
	Fiber optic and Other Cables	X	X	X	X

Fixed buildings or structures could include those used for testing purposes, deployment, or both. As described above, the MDA would evaluate DoD-owned buildings for continued or adaptive use by the DoD or other U.S. Government agencies. Following the decision to decommission, any necessary decontamination activities would be performed. Buildings owned by the DoD that are not assigned new missions could be sold and the title transferred to the new owner. Any space devoted to BMDS activities in government contractor or contractor facilities would be returned to the host installation. All BMDS-related equipment would be removed according to decommissioning regulations.

Other fixed BMDS components include launch pads, in-ground missile silos, and runways. Launch pads, silos, and runways located at the various DoD installations, upon completing their BMDS mission, might be assigned new DoD missions and might not

need to be decommissioned. Other government launch facilities include those run by the NASA such as Kennedy Space Center.

Private facilities include those owned by states or private organizations such as the KLC, which is run by the Alaska Aerospace Development Corporation. Upon termination of any BMDS testing or deployment activities conducted on the grounds of these facilities, any private assets and components used by MDA to support testing or deployment would be returned to full control of the host installation or otherwise disposed per existing contractual agreement.

Utilities installed in new or existing facilities as part of the BMDS mission would include water/sewer systems and fiber optic or other cables. Depending on the decommissioning decision related to any related DoD-buildings or structures, utilities could be left in place if the potential existed to use them for future DoD or other entity purposes. They would either be passed to the existing owner or host installation if installed on contractor property. Should a related structure be transferred to a new owner, utilities likely would be left in place.

The scope of the BMDS includes some testing and potential deployment at locations abroad. Decommissioning options for international buildings, launch locations, or utilities would be the same as for domestic locations. However, it is expected that the extent of the BMDS presence in other countries would be less than in the continental U.S.

Mobile land-based components include transportation vehicles (e.g., trucks, vans and trains) and missile launchers. Equipment removed from the mobile land-based components would be refurbished and transferred to an alternate use, demilitarized, or dismantled and disposed. Upon completion of their BMDS mission, DoD-owned transportation vehicles would either be assigned another mission or be disposed or sold by DoD. Vehicles owned by government contractors or private companies would be returned to their original owners following any decontamination required. Missile launchers, such as the THAAD mobile launcher, which uses a U.S. Army Heavy Expanded Mobility Tactical Truck with Load Handling System Truck would be disassembled and disposed. Some missile launcher interiors were coated with a specialized paint containing chromium. Disposal of chromium contaminated paint dust or water used in the removal of the paint would require disposal according to applicable Federal and State regulations.

Following the decision to decommission, any necessary decontamination activities would be performed. Land areas would be restored to previous conditions or other condition compatible with planned land use of the site. Demilitarization of land-based components would be conducted in accordance with the applicable category of DoD 4160.21-M-1, Appendix 4 "*Demilitarization Requirements for Munitions List Items,*" or other applicable requirements. Disposal of land-based components would involve the removal

of BMDS equipment and assets. The components could be left in place and a new mission assigned for them. The components could be returned to the owners of the host facility (if not DoD-owned) or transferred to new owners. Transfer would occur under an interagency agreement, memorandum of understanding, lease agreement, or other agreement.

The MDA would decommission the three current airborne sensor aircraft (HALO I, HALO II, and Widebody Airborne Sensor Platform [WASP]) and future airborne sensors when they are no longer needed to support the MDA testing program. MDA would remove the sensors and other government property from the aircraft and then decommission the aircraft by transferring to another government agency, selling as excess government property, salvaging usable parts, or mothballing at a government airfield. MDA is currently purchasing the HALO aircraft.

Under the Measurements Program, countermeasures would be recycled or reused for alternate DoD missions. Simulants and submunitions used for lethality testing also would be recycled or reused, where possible, or disposed in accordance with applicable regulations.

4.1 Alternative 1 – Implement BMDS Using Land-, Sea-, and Air-Based Weapons Platforms

4.1.1 BMDS Components

The following analyses are organized by component and subcomponent. The analyses are specific to each resource area (i.e., air quality, airspace, biological resources, geology and soils, hazardous materials and hazardous waste, health and safety, noise, transportation, and water resources) based on the impacts from the life cycle activities associated with each component. Where activities that are not unique to the life cycle phase or component and have the potential to result in similar environmental impacts, they were addressed together to eliminate redundancy. Where activities that are not unique to an individual component and have the potential to result in similar environmental impacts, they were addressed together to eliminate redundancy. As previously discussed under the Description of Life Cycle Activities and Development Phase Activities, manufacturing, site preparation and construction, and transportation of components are discussed under Support Assets. Because such activities would be performed by or on support assets, the impacts from manufacturing, site preparation and construction, and transportation activities associated with each BMDS component are discussed under Support Assets.

4.1.1.1 Weapons - Lasers

As described in Exhibit 4-3, the analysis for lasers is based upon impacts from the activation of the laser.

Air Quality

Operation of a COIL would result in gaseous emissions of water vapor, CO_2, oxygen, helium, nitrogen (N_2), ammonia, chlorine, H_2, and iodine. Liquid hydrogen peroxide also would be released. Ammonia and chlorine are hazardous substances. At altitude, the gases produced by the laser are exhausted into the air. During activation from land and sea platforms (assuming that sea-based laser activation was done under the same test conditions used for ground testing), most of the gaseous emissions produced by the laser would be captured in an air pollution scrubber. The estimated quantities released and scrubbed (for laser activation from land and sea platforms) in a single lasing event are shown in Exhibit 4-7. (U.S. Department of the Air Force, 1997b)

Exhibit 4-7. Estimated In-Flight COIL Gaseous Emissions in Kilograms (Pounds)*

Chemical	Total Quantity Produced per Laser Activation Kilograms (Pounds)	Quantity of Emissions Released to Atmosphere for Air Platform Laser Activation Kilograms (Pounds)	Quantity of Emissions Captured in Solution by Scrubber for Land and Sea Platform Laser Activation Kilograms (Pounds)	Quantity of Emissions Released to Atmosphere for Land and Sea Platform Laser Activation Kilograms (Pounds)
Ammonia (recovered in closed-loop system)	N/A	N/A	N/A	N/A
Carbon dioxide	761 (1,677)	761 (1,677)	0 (0)	761 (1,677)
Chlorine	29 (63)	29 (63)	24 (53)	5 (10)
Helium/N_2	86 (190)	86 (190)	0 (0)	86 (190)
H_2	20 (43)	20 (43)	0 (0)	20 (43)
Iodine	10 (23)	10 (23)	9 (20)	1 (3)
Oxygen	219 (483)	219 (483)	0 (0)	219 (483)
Water	1,389 (3,063)	1,389 (3,063)	1,181 (2,603)	209 (460)

*Calculations subject to rounding
Source: U.S. Department of the Air Force, 1997b

Land and Sea Operating Environments

Impacts to air quality from the activation of the COIL from land or sea platforms would be minimal, given the short duration of the laser operation (less than 30 seconds [U.S. Department of the Air Force, 1997b]) and the propensity of hot gases in the emission

cloud to rise. Because a small amount of chlorine may remain after scrubbing and be released to the atmosphere, rain within two hours of laser activation could cause hydrochloric acid to form and be deposited in small quantities. (U.S. Department of the Air Force, 1997b)

Under high humidity or rainy conditions, chlorine exhaust would be removed from the atmosphere in a shorter amount of time, as the chlorine is converted to hydrochloric acid. Because of their humid climates hydrochloric acid would likely be produced as a result of laser activation in a number of biomes including Arctic Tundra Coastal, Sub-Arctic Taiga Coastal, Deciduous Forest, Deciduous Forest Coastal, and Mountain Biomes. In addition, hydrochloric acid could be produced in the Sub-Arctic Taiga, Chaparral, Grasslands, and Savanna Biomes when cool and humid conditions exist during laser activation activities. The strong winds in the BOA would support the rapid dispersion of emissions. Given the dry conditions in the Desert Biome, it is unlikely that chlorine would be converted to hydrochloric acid. The Tropical Coastal Biome is generally humid but the temperatures do not cool enough to convert any chlorine produced as a result of laser activation to hydrochloric acid.

Hydrochloric acid produced as a result of the interaction between laser emissions and moisture in the air has the potential to produce impacts on biological resources, including plants and aquatic animals, and water quality. The extent and relative significance of the impact depends on the site-specific receptors present at the location. However activation of lasers, in general, would result in a small amount of chlorine being converted to hydrochloric acid, which would be further diluted by rain water.

Air Operating Environment

Impacts to air quality from laser activation from air platforms would result in similar impacts to those discussed above for land and sea operating environments. However, the potentially harmful substances would be released at approximately 12,192 meters (40,000 feet) above the Earth’s surface and therefore, would be less likely to affect ground-level air quality. High exhaust gas temperature would result in positive buoyancy, allowing the exhaust emissions to rise quickly. The high exit velocity of the exhaust gases and the chemical composition of the exhaust would further increase the rate of dispersion and increase the altitude at which dispersion occurs. Therefore, the gases would not accumulate in any significant quantities, and no significant impact to air quality would be expected due to activation of lasers from air operating environments. (U.S. Army Space and Strategic Defense Command, 1998b)

If the COIL were operating in the upper reaches of the troposphere and in the lower stratosphere (up to 12 kilometers [7 miles]), chlorine exhaust emissions would be converted quickly to forms that dissolve in water and would be removed from the

atmosphere. (U.S. Department of the Air Force, 1997b) Chlorine may be converted to hydrochloric acid, which has the potential to increase the acidity of precipitation.

Ammonia is water-soluble and would dissolve in water and be removed from the atmosphere in approximately 20 days. (Seinfeld, 1986, as referenced in U.S. Department of the Air Force, 1997b) Emissions of chlorine and ammonia from the COIL would be insignificant compared to the amount of chlorine and ammonia released by industrial sources every year. (U.S. Department of the Air Force, 1997b) Emissions of CO_2 associated with operation of the COIL would be minimal and would not be expected to contribute significantly to global warming.

Chlorine is capable of destroying ozone, which is beneficial in the upper atmosphere for blocking harmful rays from the sun. If the emissions occur in the lower stratosphere (above the troposphere), the local concentration of chlorine would increase approximately 35 percent for a short period of time (less than 24 hours). (MDA, 2003a) The increased levels would return to background levels within several hours as atmospheric winds disperse the chlorine. Operation of the COIL in the stratosphere would be spread out over time, thereby eliminating the possibility for local, cumulative effects.

In the event that the aircraft is unable to land at the appropriate landing location, it may be necessary to jettison aircraft fuel and laser chemicals. The laser chemicals could be discarded at a minimum altitude of at least 4,572 meters (15,000 feet). Chemical dispersion modeling has shown that release of liquids used by the COIL at this altitude will not reach the ground and would be diluted in the atmosphere. (MDA, 2003a) Laser chemicals include hydrogen peroxide, ammonia, chlorine, helium, N_2, and iodine. Iodine would be carried as a solid and would not be jettisoned. If the chemicals could not be released at or above this height, the laser chemicals would remain onboard until the air operations could be grounded.

B-747 aircraft would be used for air-based lasers. B-747 fire suppression systems contain 150 kilograms (330 pounds) of Halon 1301 and 9 kilograms (20 pounds) of Halon 1211, both of which are Class I ozone-depleting substances that contribute to ozone depletion when released to the atmosphere. Use of Halon CFC fire suppression systems would take place only in emergency situations, which would be extremely rare. In the case of a fire, the amount of Halon released would be small compared to the amount of CFCs already present in the atmosphere. Fire suppression substitutes are being developed and evaluated and may be available for future operation of lasers in an air operating environment.

Airspace

Land and Sea Operating Environments

Ground testing of HELs that would occur in indoor facilities would have no effect on airspace in any biome considered in this PEIS. Outdoor activation of lasers from land or sea operating environments could impact the use of airspace. Close coordination with the FAA ARTCC and relevant military installations with responsibility for airspace management would minimize the potential for any adverse impacts on airspace use. Activation of lasers would occur in cleared airspace within designated airspace areas.

Air Operating Environment

Laser activation from air platforms would occur at an altitude of approximately 12,192 meters (40,000 feet). The laser beam would be pointed horizontally or upward. Activation of lasers would occur in cleared airspace within designated airspace use. Close coordination with the FAA ARTCC and relevant military installations with responsibility for airspace management would minimize the potential for any adverse impacts on airspace use.

Biological Resources

Land and Sea Operating Environments

Ammonia and chlorine produced from the land- and sea-based operation of the COIL could harm underlying vegetation and wildlife. Chlorine is known to injure plant leaves and affect wildlife. Direct effects could include discoloration, foliage loss, and changes in species composition. (U.S. Department of the Air Force, 1997b) Birds flying through the exhaust plume might be exposed to concentrations of hydrochloric acid, which could irritate eye and respiratory tract membranes. However, the high temperature of the emissions, the noise produced by support equipment, and visual cues of the emissions would likely cause birds to fly away from the launch area and therefore, prevent them from being exposed to the chlorine exhaust.

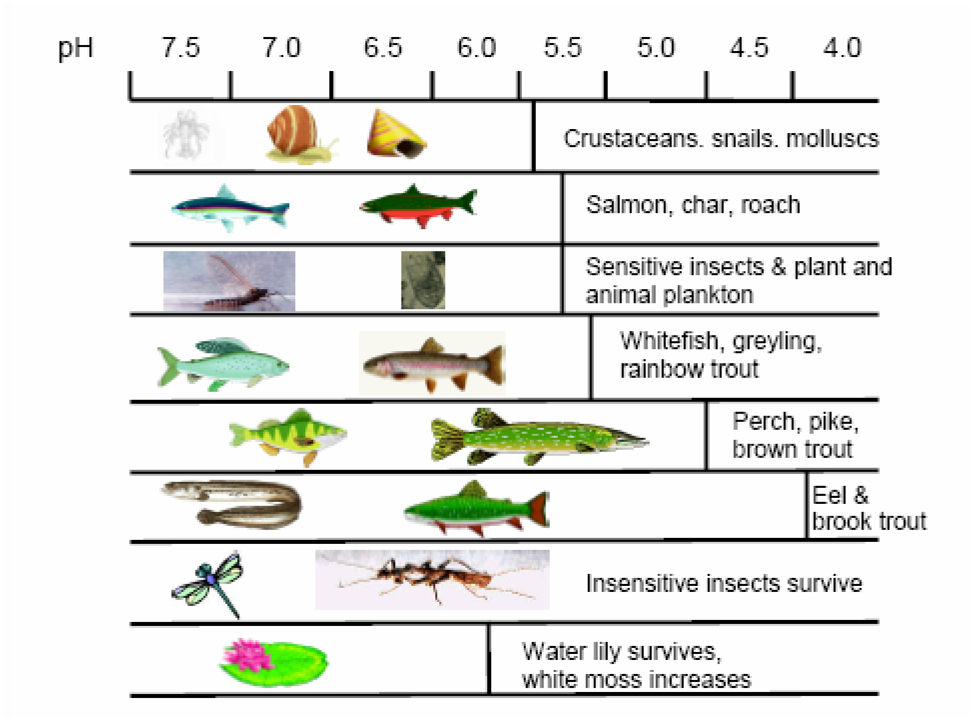
Furthermore, studies involving a variety of laser projects in New Mexico indicate that cumulative impacts to wildlife from laser propagation are negligible. (U.S. Army Corps of Engineers, 1989)

The presence of hydrochloric acid in freshwater bodies may cause temporary increases in water acidity and could alter the regular functioning of the aquatic ecosystem. However, saltwater tends to neutralize acid; therefore, significant acidification does not occur in the ocean and most estuaries, where freshwater and saltwater combine. (EPA, 2003g)

Nonetheless, deposition of HCl into the ocean may create a temporary hazard to marine wildlife. Special consideration should be given to any potential impacts to Essential Fish Habitat and efforts, such as scrubbing emissions, should be made to mitigate the impacts. Once deposited, hydrochloric acid would be diluted and dispersed by the receiving waters. Impacts would be limited to a small area surrounding the point of contact, as the waves and ocean currents would inhibit widespread deleterious effects to marine wildlife.

In environments where there are water bodies, including bogs, fens, marshes, shallow lakes, rivers, and wetlands, chlorine would be converted to an acidic form, where it could alter the pH of the water body. The activation of lasers would not be expected to cause a significant increase in water acidity; however, site-specific analyses would be needed to consider specific impacts to individual locations. In general, the Sub-Arctic Taiga Coastal, Deciduous Forest, Deciduous Forest Coastal, and Mountain Biomes are likely to have water bodies that could be affected by an increase in acidity. Much of the Deciduous Forest Biome is already affected by acidic precipitation; therefore, its regional flora and fauna may not be able to tolerate additional acidic toxicity from laser activation. The presence of hydrochloric acid in prairie potholes in the Grasslands Biome could lower the pH of the water (making it more acidic), which could have a negative effect on waterfowl, shorebirds, and waterbirds that stopover during migration and/or breed in the waters. Mountain lakes are particularly sensitive to the effects of acidification because they have soft water, which does not neutralize acid readily. Furthermore, mountain lake ecosystems quickly show the effects from an external input. As a result, some mountain lake wildlife might not be able to adapt to a lower pH level quickly enough to absorb the effects of increased water acidity without harm. (PECO/COPERNICUS, 1999) Other biomes including Arctic Tundra Coastal, Sub-Arctic Taiga, Chaparral Coastal, Desert, Tropical Coastal, BOA, and Savanna are unlikely to experience increased acidity in surface waters either because hydrochloric acid is unlikely to be produced as a result of laser activation or because surface water is uncommon in these areas. An increase in acidity could affect pH-sensitive aquatic species, as shown in Exhibit 4-8. This has the potential to adversely affect biodiversity; however, this potential affect would be limited to the areas surrounding the laser activation site. The overall increase in acidity, and therefore, the impact to biodiversity would not be expected to be significant.

Exhibit 4-8. Freshwater Species Tolerance to Acidity



Source: Atmosphere, Climate and Environment Information Programme, 2003

Species including birds, pinnipeds, and sea otters are less likely to be impacted by laser activation related noise than other noises. Given the short duration (less than 30 seconds) and proposed infrequent operation of the lasers, any startle responses in animals would be short-lived and localized to the area near the activation site. (U.S. Department of the Air Force, 1997b)

Indoor testing would be contained and would not damage vegetation or wildlife in any biome. During outdoor testing, laser beams could either be directed upwards toward air targets or horizontally towards ground targets. If the beam were directed at an upward angle, vegetation and terrestrial wildlife would not be affected. The probability of the laser beam striking a bird is very low. If the beam is directed horizontally toward ground targets, it could pose a fire hazard to vegetation or cause skin or eye damage to wildlife. Precautions would be taken to prevent harm to vegetation and wildlife.

When the light energy of the laser beam is focused, damage due to thermal heating of the retina or a photochemical change in the retina would most likely occur (in the same way that a magnifying glass can be used to focus light energy from the sun to produce a hot spot). (Swope, 1969, as referenced in U.S. Department of the Air Force, 1990) Damage to the fovea (a small part of the retina that provides acute vision) could result in a severe visual handicap. If the eye were not focused on the laser source, the light energy would not be focused to a point on the retina but would be spread out over a larger area of the

retina and would not be as likely to cause damage. Also, if the eye were pointed somewhere off to the side rather than directly at the source, any damage to the retina would be outside the fovea and would be less likely to produce severe visual handicap. (U.S. Department of the Air Force, 1990)

Ground testing of ABLs would use equipment that would simulate atmospheric conditions at the altitude where the laser would be used. The equipment would operate for a few minutes or less, and would generate noise that could affect wildlife. This noise could cause flushing in birds and temporary abandonment of nesting and other normal activities. These noises may startle animals and cause them to flee the area and abandon normal activities. However, studies indicate that birds and animals generally return to normal activities within a short time following noise disturbances. (Manci, et al., 1988) Specifically, a 1982 study by Stewart found that birds exposed to 115.6 to 145.5 dBA short intensity noise events returned to their nests within 2 to 10 minutes after the disturbance. (Stewart, 1982, as referenced in Manci, et al., 1988) In addition, a 1980 study by Jehl and Cooper used shotgun blasts and explosives to simulate short duration noise events and found that nesting birds returned within 30 seconds of the disturbance. (Jehl, J.R and C.F. Cooper, 1980, as referenced in Manci et al, 1988)

Air Operating Environment

Impacts to biological resources from laser activation from air platforms would result in similar impacts to those discussed above for land-based operations. However, the potentially harmful substances would be released at approximately 12,192 meters (40,000 feet) above the Earth's surface and therefore, would be less likely to affect human health, wildlife, or vegetation. Emissions would be diluted and dispersed quickly in the atmosphere. Terrestrial biota would not be exposed to significant concentrations of emissions. The laser beam would be pointed upward; and therefore, the test geometry would prevent the possibility of harming terrestrial wildlife directly from contact with the beam. Because the laser is activated in the upper troposphere or above, the potential for the beam striking birds in flight would be low.

A misdirected laser beam would have virtually no potential to impact any moving or stationary individual animal, either on land, in the air, or in the sea. The light energy would be reduced (i.e., less concentrated) and would be less able to cause injury because the beam's width would increase due to atmospheric refraction as it approached the Earth's surface. Exposure to the beam would be extremely short due to the rapidity with which the beam would swing past the animal or would be shut off; and therefore, damage would be minimal. (U.S. Department of the Air Force, 1990)

Geology and Soils

Land Operating Environment

Only small amounts of emissions from the operation of the COIL on the ground would be released and would not be expected to affect geology and soils in any biome. Ground testing equipment would receive the laser emissions and scrub them using a vacuum device before releasing them into the atmosphere. Use of the vacuum system would reduce the amount of emissions that could affect geology and soils.

Under rainy or humid conditions, a small amount of chlorine produced from the operation of the COIL would be deposited on the soil as hydrochloric acid, which could result in a temporary increase in soil acidity that might have a short-term effect on vegetation and soil-dwelling microorganisms. The intensity of the acidic effect is a function of the amount of limestone (calcium carbonate) in the soils.

Soils that are strongly leached (removed of nutrients, including calcium) and therefore, acidic could be adversely affected by the addition of hydrochloric acid which could further increase soil acidity. This could occur in the Arctic Tundra, Sub-Arctic Taiga, Savanna, Mountain and parts of the Deciduous Forest, and Tropical Biomes.

Soils with large amounts of calcium carbonate have nearly unlimited buffering capacities and rarely show effects of acidification. (EPA, 2003g) This would be true for soils in the Grasslands, and parts of the Deciduous Forest including Florida and islands in the Pacific and Atlantic Ocean that are limestone-based. However, many soils common throughout the Deciduous Forest Biome lack calcium carbonate due to the warm, humid climate that leads to rapid weathering and subsequent leaching of minerals in soils, including calcium and therefore might be subject to impacts from increased soil acidity.

The Chaparral and Desert Biomes would be unlikely to produce hydrochloric acid as a result of laser activation and therefore soils in these biomes would not be subject to acid deposition from this source.

Accidental releases of spent laser chemicals would be contained in accordance with site-specific spill plans that minimize impacts on geology and soils. In the case of an accidental fire, liquid and solid laser chemicals would either be consumed or contained. Chemicals consumed by the fire would be released as gases and would not impact geology or soils. Remaining laser chemicals would be contained by spill control measures and would be removed and disposed in accordance with standard procedures.

Air Operating Environment

Activation of lasers from an air platform would generally occur at approximately 12,192 meters (40,000 feet). Emissions would occur above the mixing height and might occur above the troposphere. Gaseous emissions occurring at this altitude would be dispersed and diluted in the atmosphere and would not reach the ground surface. Therefore, there would be no impact to geology and soils.

Sea Operating Environment

Laser activation on sea platforms would result in similar impacts to those discussed for land platforms. The small quantities of substances released would be dispersed by atmospheric winds or the motion of the ocean currents and waves without affecting geology and soils on the ocean floor beneath the sea operating environment.

Hazardous Materials and Hazardous Wastes

Land and Sea Operating Environments

COIL chemicals include chlorine (Cl_2), iodine, and hydrogen peroxide. Effluents from the operation of the HEL are managed by use of chemical scrubbers and chemical reactions that produce non-toxic by-products. The volume of waste would depend on site-specific activities. The use and disposal of hazardous materials would be incorporated into hazardous materials and hazardous waste management documents. Hazardous materials would be stored in a centralized location and Material Safety Data Sheets would be posted at all locations where hazardous materials are stored or used. All waste would be collected and segregated as nonhazardous, hazardous, and possibly special wastes for proper disposal in accordance with Federal, state, local, and DoD requirements. Personnel would follow safety procedures to prevent exposure. All hazardous materials used and hazardous waste generated would be handled in accordance with a Hazardous Waste and Hazardous Materials Standard Operating Procedure Manual as well as applicable legal requirements. (U.S. Army Space and Missile Defense Command, 2002d) Accidental releases of hazardous materials would be contained in accordance with a site-specific spill plan.

Laser activation activities would produce the same hazardous materials and hazardous waste impacts in all of the biomes considered in this PEIS. As discussed above for impacts to geology and soils, ground testing of lasers intended for use from air operating environments would use vacuum and scrubber devices to simulate atmospheric conditions at the proposed operating altitude. Scrubbing would generate hazardous wastewater that would be contaminated and corrosive. This contaminated water would be treated and disposed in accordance with applicable regulations.

Spent laser chemicals would be neutralized and reused elsewhere in the chemical mixing facility or disposed of as waste product. This waste would be handled, treated, and disposed in accordance with standard procedures, preventing the release of contamination. In the case of an accidental fire, liquid and solid laser chemicals would either be consumed or contained. Chemicals consumed by the fire would be released as gases and would not become hazardous waste. Remaining laser chemicals would be contained by spill prevention, countermeasure, and control plans, and would be removed and disposed in accordance with applicable regulations and standard operating procedures. Laser chemical and chemical waste storage areas would operate in accordance with appropriate regulations to minimize impacts from potential spills and/or leaks.

Air Operating Environment

Emissions from laser activation from air platforms would be vented to the atmosphere while the platform is at operational altitude. Thus, emissions would not reach the Earth, and would not require treatment as hazardous waste.

In the event of an accident on the runway causing rupture of fuel bladders on the B-747, the impact on geology, soil, or water resources from the jet fuels and firefighting materials would be similar to the impact from other aircraft accidents. The liquid and solid laser fuels released in an accident on the runway would be consumed by fire or contained, and the gaseous laser fuels would either burn or vent to the atmosphere where they would not impact geology, soils, or water quality.

Health and Safety

Land and Sea Operating Environments

Laser activation activities would produce the same impacts on health and safety in all of the biomes considered in this PEIS. A Material Safety Data Sheet would be made available for each hazardous chemical in use at the facility. Storage specifications for hazardous chemicals would prevent dangerous intermixing of reactive chemicals.

Exhaust emissions from laser activation have the potential to harm human health. A safety zone would be established around the laser during operation to prevent exposure to emissions. The general public and non-operational personnel would not be permitted in the safety zone during operations; and therefore, no impact on health and safety would be expected from exhaust emissions.

Before activation activities are conducted, components would be reviewed for hazards. Personnel would be trained to handle laser chemicals and operate the laser. During ground testing of lasers, the beam would be contained in a beam containment system at

all times. During sea-based operations, a laser hazard zone would be established to prevent non-essential personnel or bystanders from crossing the direct or reflected beam path of the laser.

An accidental release of laser chemicals and chemicals used to support laser operation would have the potential to affect health and safety of workers in the vicinity of the release. The primary scenarios for an accidental release involve the transfer of the reactants from the loading truck to the ground storage tanks, transfer from the storage tank to the test apparatus, a catastrophic storage container failure, and a massive release of hazardous chemicals resulting either from the slow combustion or the detonation of compounds where reactants are stored. (BMDO, 2001) Spill control procedures would be followed on military installations, and emergency response personnel would be trained to respond to such emergencies.

Laser beams can cause serious health problems if they contact the skin or eyes. Hazard distances would be determined for each laser depending on the hazardous and adverse biological impacts it has on the eye or skin. A spherical exclusion area would be established around the laser during operation. While the intended beam direction is the most likely hazard area, the spherical shape of the exclusion area would account for laser scatter, the intensity of which can be as strong as or weaker than the original beam. HELs are dangerous at the source of the laser beam, and they become more dangerous around the focus point, where the beam has the smallest cross-sectional area. The strength of a laser beam is attenuated and scattered as it moves through the atmosphere. Lower energy lasers (such as those used in laser sensing and tracking systems) may not be dangerous at the source of the beam, but may become dangerous around the focus point.

During ground testing activities, the laser beam would be directed away from population centers. Range areas would be used during ground testing and public access to these areas would be restricted. Laser targets would be designed to keep any spectral hazard on the range or to exit at a safe altitude. Hazard zones would be blocked off to prevent exposure to personnel. Target backstops would be used in case the laser misses the target.

Air Operating Environment

The accidental release of laser chemicals onboard an aircraft during flight would be highly unlikely. The accidental release of chemicals inside the aircraft during flight would not endanger the flight crew because the aircraft would include a pressure bulkhead that separates the chemical storage areas from the flight crew area. This pressurized bulkhead would ensure that any laser emissions would not penetrate the inhabited portion of the aircraft. Chemicals could also be jettisoned to minimize the amount released inside the aircraft.

Flight test activities would be configured so that reflected lasers would be contained within range boundaries. Exposure to a reflected laser beam would likely be very short, less than 0.01 seconds in duration and would not impact health and safety. (U.S. Air Force, 1997a, as referenced in MDA, 2003a)

Noise

Land and Sea Operating Environments

Laser activation activities would produce the same noise levels in all of the biomes considered in this PEIS. The potential for impact would depend on the specific operating location. Operation of equipment to support tests of lasers on land and sea operating environments would last for less than five minutes for each test. (U.S. Department of the Air Force, 1997b) The public and on-site personnel would be excluded from the area where the noise from this equipment would be detrimental. The size of this exclusion area would be determined using OSHA limit for noise exposure.

High noise levels between 110 and 134 dBA are associated with the pressure recovery system during activation of the laser. All personnel who could be affected would be evacuated from the area for their protection or required to wear appropriate hearing protection.

Air Operating Environment

Activation of the laser on an air platform would take place at an altitude of approximately 12,192 meters (40,000 feet), and noise resulting from this activation would not affect ground level noise.

Transportation

Land and Sea Operating Environments

Air traffic is the transportation mode that might be affected by the activation of lasers. The use of lasers from land and sea platforms has the potential to impact the use of airspace if the laser beam were directed upwards.

Air Operating Environment

The use of lasers from air platforms could also impact the use of airspace. The impacts on airspace are discussed above. These impacts would be the same in all of the biomes considered in this PEIS.

Water Resources

Land Operating Environment

Chlorine released by the operation of the COIL would react with water vapor in the atmosphere to produce hydrochloric acid. Hydrochloric acid absorbed by surface waters would cause a temporary pH change such that any alteration of the water's pH would be almost imperceptible. (U.S. Department of the Air Force, 1997b)

In areas where precipitation is heavy, catchment basins are small, and stream gradients are steep hydrochloric acid would pass quickly out of stream drainages. (FAA, 1996) Ocean waters would not be significantly affected by changes in pH due to sea water's ability to readily neutralize acid.

Usually the chlorine exhaust cloud would be highly dispersed before coming into contact with surface waters and would become dilute hydrochloric acid upon mixing with water. Under rainy or humid conditions, chlorine could be concentrated spatially or locally in nearby ground and surface water sources. This could occur in the Arctic Tundra, Sub-Arctic Taiga, Deciduous Forest, and Mountain Biomes. In addition, hydrochloric acid could be produced in the Sub-Arctic Taiga, Chaparral, Savanna, and Grasslands Biomes when cool and humid conditions exist during laser activation activities. The strong winds in the BOA would support the rapid dispersion of emissions. Given the dry conditions in the Desert Biome it is unlikely that chlorine would be converted to hydrochloric acid. The Tropical Biome is generally humid but the temperatures do not cool enough to convert the chlorine produced as a result of laser activation to hydrochloric acid.

Hydrochloric acid deposition in surface waters may cause temporary increases in water acidity. Once deposited, hydrochloric acid would be diluted and dispersed by the receiving waters. Therefore, hydrochloric acid emissions would have minimal impacts on water pH levels and would not be considered harmful.

Sources of potential ground water contamination are spills of cooling water or stored chemicals and/or leaks from the chemical waste and sludge tanks. Accidental releases of spent laser chemicals would be contained in accordance with site-specific spill plans that minimize impacts on water resources.

In the case of an accidental fire, liquid and solid laser chemicals would either be consumed or contained. Chemicals consumed by the fire would be released as gases and would not impact water resources. Remaining laser chemicals would be contained by spill prevention and control measures, and would be removed and disposed in accordance with standard procedures.

Ground testing of ABLs would use vacuum and scrubbing equipment that would result in hazardous wastewater that would need to be treated and disposed in accordance with applicable regulations.

Air Operating Environment

Activation of lasers from an air platform would occur at an altitude of approximately 12,192 meters (40,000 feet), which is higher than the mixing height. Emissions would be dispersed by wind and diluted in the atmosphere and would not impact surface water resources.

Sea Operating Environment

Impacts from laser activation during sea-based operations would be similar to those described above for land operations. The addition of hydrochloric acid to the ocean from the operation of the COIL would cause a slight increase in acidity of waters in the immediate vicinity of the contact point. However, saltwater tends to readily neutralize acid and the continual movement of waves further disperses and dilutes the chemicals. Therefore, significant acidification would not occur in the ocean.

4.1.1.2 Weapons - Interceptor*s*

As described in Exhibit 4-3, the analysis for interceptors is based upon impacts from prelaunch, launch/flight, and postlaunch activities.

Air Quality

Prelaunch Activities

For pre-fueled liquid propellant boosters and solid propellant boosters, prelaunch activities, such as elevating the booster to the launch angle and attaching fins to the booster, would not significantly impact air quality in any of the biomes considered in this PEIS.

For non-pre-fueled liquid propellant boosters, the prelaunch activity with the greatest potential for air quality impacts is fueling. All fueling procedures would need to be approved by the site where the activity is to occur, and associated emergency response plans would need to be reviewed before beginning fueling activities. Although total oxidizer and fuel vapor emissions would vary depending on the propellant transfer equipment used and how it is assembled, it is anticipated that only very small amounts (approximately 10 grams [0.4 ounces]) of oxidizer vapors would be released to the atmosphere during the oxidizer transfer operation. A negligible amount of fuel vapors

would also be released into the atmosphere during fuel transfers. (U.S. Army Space and Missile Defense Command, 2002c)

Propellant releases, although unlikely, could occur during propellant loading or transfer due to failure of transfer equipment or valves. An analysis conducted for the *Liquid Propellant Targets Environmental Assessment* (2002) assumed a leak over a three-minute period would release up to 17 liters (4.5 gallons) of oxidizer inhibited red fuming nitric acid (IRFNA), hydrogen peroxide, or nitrogen tetroxide, or hydrazine fuel.

Boosters could be shipped to the test range with the kill vehicle attached, or the booster could be shipped separately from the kill vehicle. In either case, the fuel and oxidizer tanks would be installed in the kill vehicle at the test site. If the booster is shipped separately from the kill vehicle, the kill vehicle would be mated to the booster in a missile assembly building. These structures are commonly used for these types of activities, and no impacts to air quality would be expected from the mating and assembly process. (U.S. Army Space and Missile Defense Command, 2003)

Launch/Flight Activities

Launches of pre-fueled liquid propellant boosters would use a solid propellant gas generator as the ignition source. This solid propellant gas generator would have emissions similar to those discussed for solid propellant boosters; however, the quantities involved would be significantly smaller. The primary exhaust products of pre-fueled liquid propellant boosters are water, H_2, N_2, hydrogen fluoride, CO_2, and CO.

Emissions from the launch of pre-fueled liquid propellant boosters would have minimal impact on air quality. (Cortez III Environmental, 1996) The only HAPs produced from launches of these missiles would be from the solid propellant gas generator, which would produce approximately 0.05 kilograms (0.10 pounds) of hydrochloric acid per launch, which is much less than the Clean Air Act regulatory reporting requirement of nine metric tons (10 tons) per year. (U.S. Department of the Air Force, 1997b)

Launches of non-pre-fueled liquid propellant boosters would be started by using triethylamine and dimethylaniline as an initiator fuel. The initiator fuel would have emissions similar to those discussed for the primary exhaust products for liquid propellants. The primary exhaust products of non-pre-fueled liquid propellant boosters are CO, CO_2, H_2, N_2, and water. Emissions from the launch of non-pre-fueled liquid propellant boosters would have minimal impact on air quality.

The primary exhaust products of solid propellant boosters are HCl, CO, NO_X, and aluminum oxide (Al_2O_3). HCl and CO emissions are gases and Al_2O_3 is emitted as particulate. CO and NO_X emissions are further oxidized to CO_2 and NO_2 due to the high temperatures experienced during launch; however, the quantities released from a single

test event are not expected to contribute to localized accumulation of greenhouse gases. Gaseous HCl produced by launches of solid propellant boosters combines with water in the atmosphere to create hydrochloric acid aerosol, which may contribute to the formation of acid rain. This is a particular concern in high precipitation areas or humid biomes where moisture in the air could aid the conversion of HCl to hydrochloric acid. Several biomes including Arctic Tundra, Sub-Arctic Taiga, Deciduous Forest, and Mountain Biomes are considered humid. In addition, acid precipitation could be produced in the Sub-Arctic Taiga, Chaparral, and Grasslands Biomes when cool and humid conditions exist during launch activities.

As the booster proceeds through the layers of the atmosphere the impact of emissions from launch/flight activities varies depending on the propellant system used. One emission of concern produced by some liquid propellant boosters is CO, which can cause radiative heating and minor chemical reactions when emitted in the stratosphere.

Launch/flight activities can contribute to global warming through the emission of greenhouse gases. These emissions could include water vapor and CO_2. However, launch/flight activities would not contribute significantly to the total emissions of these gases, and so would not have a significant effect.

Within the stratosphere, ozone depletion is a primary concern. Ozone in the stratosphere provides a protective layer shielding the Earth from ultraviolet radiation and subsequent harmful effects. Ozone may be depleted through complex reactions with chlorine, Al_2O_3, and NO_X.

Solid propellant boosters emit HCl through high temperature afterburning reactions in the exhaust plume, which could partially be converted to atomic chlorine and molecular chlorine (Cl and Cl_2). These active forms of chlorine can contribute to localized ozone depletion in the wake of the booster. The USAF atmospheric interceptor technology (*ait)* vehicle may be representative of solid propellant boosters that would be used as part of the BMDS. The *ait* would spend approximately 25 seconds in the stratosphere at an altitude between 15 and 40 kilometers (9 and 25 miles). The first stage of the *ait* would deposit approximately 181 kilograms (400 pounds) of HCl and approximately 249 kilograms (550 pounds) of combined Cl and Cl_2 between an altitude of 15 kilometers (9 miles) and 34.6 kilometers (21.5 miles). This represents less than 14 kilograms (30 pounds) of active chlorine being distributed per kilometer of altitude traveled by the test vehicle. The second stage of the *ait* would contribute a total of approximately 3 kilograms (6 pounds) of HCl, Cl, and Cl_2 between ignition and 40 kilometers (25 miles) altitude. It is estimated that less than one pound per kilometer of altitude of the active forms of chlorine would be emitted by the second stage. Due to the large air volume over which these emissions would be spread, and because of rapid dispersion by stratospheric winds, the active chlorine from launches would not contribute to significant localized ozone depletion.

The emission of Al_2O_3 has been the subject of study with respect to ozone depletion. Al_2O_3 is emitted as solid particulates that may serve as sites for atmospheric chemical reactions. The studies (Molina, 1996, as referenced in U.S. Department of the Air Force, 1997a) indicate that Al_2O_3 can activate chlorine. The exact magnitude of ozone depletion that can result from a build-up of Al_2O_3 over time has not yet been determined quantitatively, but appears to be insignificant based on existing analysis.

Exhaust from the first stage of the USAF *ait* vehicle is approximately 27 percent by weight Al_2O_3, and the second stage exhaust is 35.4 percent Al_2O_3 by weight. The total amount of Al_2O_3 deposited between an altitude of 15 and 40 kilometers (9 and 25 miles) by each USAF *ait* flight is approximately 535 kilograms (1,180 pounds) from the first stage and 38 kilograms (83 pounds) from the second stage. The Al_2O_3 emitted during *ait* flight is in the form of smooth particles with sizes varying in diameter from less than one micron to ten microns. (Beiting, 1997, as referenced in U.S. Department of the Air Force, 1997a) Depending on the altitude where these particles are emitted, they may diffuse out of the stratosphere over a period of weeks to a few years. The particles would participate in reactions that may cause ozone depletion during the time that they stay in the stratosphere. (Molina, 1996 and Jackman, 1996, as referenced in U.S. Department of the Air Force, 1997a) The Al_2O_3 solid particles would have the potential to contribute to ozone-depleting reactions while in the stratosphere but because of the large air volume in the stratosphere and rapid mixing, they would not cause significant localized effects on stratospheric ozone depletion.

NO_X is produced during high temperature reactions known as afterburning in the exhaust plume of solid propellant boosters. As the temperature of the exhaust decreases with increasing altitude, less NO_X is formed. For the USAF *ait*, the first stage afterburning production of NO_X is nearly stopped before the vehicle reaches the stratosphere. The total NO_X deposited in the stratosphere is approximately two kilograms (four pounds) from the USAF *ait* first stage and less than 0.5 kilograms (one pound) from the second stage. Stratospheric winds would disperse these quantities rapidly; therefore, no significant effect on ozone depletion would be expected from these emissions. (Molina, 1996, as referenced in U.S. Department of the Air Force, 1997a)

Land and Sea Operating Environments. Because the booster is moving away from the point of launch, only a small portion of the launch exhaust would be emitted near the launch area. In general, biomes with moderate to high winds experience less concentration of air emissions because the winds tend to disperse the ground level emissions. These biomes may include: Deciduous Forest, Chaparral, Desert Biomes, and the BOA. Other biomes including the Arctic Tundra, Sub-Arctic Taiga, Grasslands, Tropical, Mountain, and Savanna may experience higher localized concentrations of air emissions although this would depend on the site-specific conditions.

Launch activities would not be expected to bring any new stationary emission sources to the launch area; therefore, new permits or changes to existing air permits would not be required. If new stationary emission sources were introduced into the region, it is possible that additional permits or changes to existing air quality permits would be required.

Kill vehicles could use either solid or liquid propellants. The liquid propellants likely to be used on the kill vehicle are hypergolic propellants, which would be used in small quantities. Because the launch/flight of kill vehicles is not initiated until the vehicle is high above the Earth's surface, emissions released from the kill vehicle would occur above the troposphere (10 kilometers [6.2 miles]) and therefore, would not impact ground-level air quality.

Air Operating Environment. Launches of pre-fueled and non-pre-fueled liquid and solid propellant boosters from air-based platforms would have less impact on ground-level air quality than launches from land or sea platforms because these launches would produce air emissions at a higher altitude. Using this type of operating environment, the rocket motor would be ignited at an altitude from 1.5 to 6 kilometers (0.93 to 3.7 miles). At this altitude, the booster would be ignited in the troposphere (extending to 10 kilometers [6.2 miles] above the surface of the Earth). Pollutants above the troposphere (and therefore, above the mixing layer) do not significantly impact ground-level air quality. The mixing layer allows for vertical "stirring" of air masses, which aids in the dilution of pollutants before they are slowly transported to ground level.

Postlaunch Activities

The impacts of postlaunch activities have been separated into two discussions below – one for air quality impacts when launch debris or residual propellants hit land and the other when these fall into water.

Launch Debris Hitting Land. The amount of residual propellant in the booster when it hits the ground would depend on several factors including how much propellant was in the booster at launch and how far the booster traveled during the mission. The amount of residual IRFNA in a pre-fueled liquid propellant booster could vary from 12 to 343 kilograms (26.5 to 756 pounds) and the amount of residual unsymmetrical dimethyl hydrazine could vary from 14 to 123 kilograms (31 to 271 pounds). A non-pre-fueled liquid propellant booster could impact the ground with approximately 265 liters (70 gallons) of fuel and approximately 473 liters (125 gallons) of oxidizer remaining. The residual propellants could burn upon impact, or one or both propellants could be released to the atmosphere without burning. (Cortez III Environmental, 1996)

If the propellants burn upon impact, short-term impacts to air quality would occur. The ground-based booster impact areas would be isolated from inhabited areas and would be

evacuated prior to a launch; therefore, any exceedances of the NAAQS or exceedances of health-based criteria would not endanger the public. The remote location of the impact area would allow time and distance sufficient to disperse fumes to a non-hazardous level. It is not anticipated that combustion of the propellant(s) would result in air quality impacts beyond the immediate impact site.

If the residual propellants were released to the atmosphere without burning, the IRFNA is likely to be volatilized as NO_X and nitric acid. Observations of launches of pre-fueled liquid propellant boosters at WSMR indicate that a brown cloud has been observed immediately after impact. (Wilson, 1999, as referenced in Cortez III Environmental, 1996) This cloud is likely produced by IRFNA converting to NO_X, which can induce severe irritation to the eyes, skin, and mucous membranes and can lead to suffocation. Unsymmetrical dimethyl hydrazine is a known carcinogen that can react with oxygen and release toxic fumes of NO_X if released to the air without combusting. These releases have been studied to dissipate below hazardous levels within 24 hours and to be undetectable after a period of six months. (Wilson, 1991, as referenced in Cortez III Environmental, 1996) Hydrogen peroxide and hydrocarbons would dissipate when exposed to air. Nitrogen tetroxide if released to the air without combusting would be converted to gaseous form.

Residual propellant from solid propellant boosters would likely continue to burn until expended if encased; however, if released from the motor casing, it is possible that solid propellant would not burn completely. This combustion would have a minor impact on air quality. There is a possibility that the burning solid propellant if encased could start a fire on the ground. The resulting fire could impact air quality in the area immediately surrounding the impact area.

During a mission involving a successful intercept, the kill vehicle would be destroyed and small pieces of debris would impact the Earth's surface. The small pieces of debris may temporarily serve as sites for chemical reactions in the Earth's atmosphere until the debris reaches the ground. However, the impacts to air quality would be minimal.

If the propellants in the kill vehicle were released to the atmosphere in an impact, they would either burn up, or one or both propellants could be released to the atmosphere and evaporate. Impacts from either scenario would be similar to those discussed above for propellants released from liquid propellant boosters.

Launch Debris Hitting Water. The impacts to air quality from postlaunch activities resulting in boosters and kill vehicles hitting the ocean would be similar to, but less than those impacts discussed above for boosters and kill vehicles hitting land because the residual liquid propellants would be released into the ocean rather than the air. Impacts to water quality from a direct release to water are described in the hazardous waste

section. Solid propellant, if still in the casing, might continue to burn for some time even under water. However, this would create minimal impacts to air quality.

Airspace

Prelaunch Activities

There would be no impact on airspace from prelaunch activities, including, fueling, evacuations and clearances, and road closures, because these activities do not physically interfere with navigable airspace or affect airspace scheduling.

Launch/Flight Activities

Close coordination with the appropriate FAA ARTCC and relevant military installations with responsibility for airspace management would minimize the potential for any adverse impacts on airspace use and scheduling for launches from all operating environments in all of the biomes considered in this PEIS. Launches of boosters and kill vehicles would require coordination with current aeronautics and space activities within the airspace associated with launch sites. Launch, flight, and impact of boosters and kill vehicles would occur in designated areas of cleared airspace.

Land Operating Environment. Although launches of interceptors might require closure of some airspace and would, therefore, impact the amount of available airspace, this type of activity is considered routine at many military installations and would not constitute a significant impact. Aircraft transiting the area would be notified of any necessary rerouting requirements before departing their originating airport and would thus be able to take on any additional fuel before takeoff to avoid the affected area. Launches would be scheduled such that they would not affect airborne activities outside the airspace complex(es) where they are to occur, and would not interfere with any low- or high-altitude en route airways or jet routes use by civilian or private airports in the vicinity of the launch site.

In addition, before conducting an operation that is potentially hazardous to non-participating aircraft, Notices to Airmen (NOTAMs) would be established in accordance with range safety procedures. To satisfy airspace safety requirements, the responsible official would obtain approval from the FAA, prior to conducting the launch. Provisions also would be made for surveillance of the affected airspace by radar and patrol aircraft prior to booster launch. Safety regulations dictate that hazardous operations are suspended when any non-participating aircraft enters any part of the hazard area. Operations would resume when the non-participating entrant has left the area or a thorough check of the suspected area has been performed. For these reasons, no adverse impacts to airspace are expected from ground launches.

Air Operating Environment. Within minutes after launch, the booster would be propelled to an altitude of several hundred thousand feet, well above the typical altitudes used by commercial aircraft. The launches, flight trajectory, and ground impacts would occur at sufficient distance and altitude to be virtually unnoticed by local, non-military flying activities. Other impacts to airspace from launches of boosters from air operating environments would be as described for launches from land operating environments.

Sea Operating Environment. Potential impacts to airspace from launches of boosters from sea platforms would be minimized by coordination between airspace complexes. Procedures would be similar to those for launches from land and air operating environments. If the sea operating environment were positioned in the BOA, potential impacts would be further minimized because airspace over the BOA is not heavily used.

Establishing restricted areas would marginally reduce the amount of navigable airspace in the BOA, but because the airspace is not heavily used, the impacts to controlled and uncontrolled airspace would be minimal. If possible, the sea environment would be positioned to avoid the en route airways and jet routes that cross the BOA. Therefore, no significant impacts to the over-water airways and jet routes would be expected from any type of missile launched from a sea operating environment.

Postlaunch Activities

Impacts of postlaunch activities on airspace are discussed below addressing postlaunch debris recovery on land and in water.

Launch Debris on Land. If necessary, helicopter retrieval of debris, from boosters or kill vehicles deposited on land would be within the boundaries of the designated impact area and therefore, within the airspace complex. Debris retrieval would have no impact on navigable airspace or airborne activities outside the restricted airspace complex.

Launch Debris in Water. If debris from boosters or kill vehicles falls into water, MDA would not likely recover the debris. Therefore, helicopters and other equipment would not be used, and no impacts to airspace would be expected. If it were necessary to recover debris from water for a specific test, the impacts of debris retrieval would be analyzed as appropriate.

Biological Resources

Prelaunch Activities

There would be no impacts to biological resources from prelaunch activities for pre-fueled and solid propellant boosters and kill vehicles. For non-pre-fueled liquid propellant boosters, no more than a few grams of propellant would be released during

normal fueling operations and appropriate responses to leaks and releases would be implemented to minimize the hazard to biological resources. All fueling would be conducted using impermeable barriers appropriate for this type of activity, which would minimize the potential for a spill to impact biological resources.

Launch/Flight Activities

The presence of launch-related personnel prior to launch, noise associated with launch, and launch emissions all have the potential to impact biological resources during launch.

Informal observation at several launch facilities indicates that the increased presence of personnel immediately before a launch tends to cause birds and other mobile species of wildlife to temporarily leave the area prior to the launch. This would effectively reduce the effects of sound, launch emissions, and heat on these animals. However, personnel associated with the launch would comply with USFWS, other regulatory agency, and relevant site-specific procedures to protect biological resources including species of special concern.

The effects of noise on wildlife can be categorized as either auditory or non-auditory. Auditory effects would consist of direct physical changes, such as eardrum rupture or temporary threshold shift (temporary hearing loss). Non-auditory effects could include stress, behavioral changes, and interference with mating or foraging success. The effects of noise on wildlife vary from serious to no effect in different species and situations. Animals can also be sensitive to noises in some situations and insensitive to the same noises in other situations. (Larkin, 1996) Behavioral responses to noise also vary from startling to retreat from favorable habitat.

Launches would be relatively infrequent events. Disturbance to wildlife would be brief and would not be expected to have a lasting impact nor a measurable negative effect on migratory bird populations. Wildlife would resume feeding and other normal behavior patterns after a launch is completed. Specifically, a 1982 study by Stewart found that birds exposed to 115.6 to 145.5 dBA short intensity noise events returned to their nests within 2 to 10 minutes after the disturbance. (Stewart, 1982, as referenced in Manci, et al., 1988) In addition, a 1980 study by Jehl and Cooper used shotgun blasts and explosives to simulate short duration noise events and found that nesting birds returned within 30 seconds of the disturbance. (Jehl, J.R and C.F. Cooper, 1980, as referenced in Manci et al, 1988) Wildlife driven from preferred feeding areas by aircraft or explosions usually return soon after the disturbance stops, as long as the disturbance is not severe or repeated. (FAA, 1996) Foraging birds would be subjected to increased energy demands if flushed by the noise, but this should be a short-term, minimal effect.

Video camera observations of a wood stork colony located 0.8 kilometer (0.5 mile) south of the Space Shuttle launch pad at Kennedy Space Center showed the birds flew south

away from the noise source and started returning within two minutes, with a majority of individuals returning in six minutes. (NASA, 1997, as referenced in U.S. Army Space and Missile Defense Command, 2002c) This rookery continues to be used successfully, even though it has received peak noise levels of up to 138 dB. (American Institute of Aeronautics and Astronautics, 1993, as referenced in U.S. Army Space and Missile Defense Command, 2002c) Birds roosting within 250 meters (820 feet) of Titan launch complexes at Cape Canaveral Air Force Station have shown no mortality or reduction in habitat use.

Fixed wing aircraft and helicopters are often used for routine flights around the Arctic Tundra Biome. These aircraft noises have been shown to produce sounds that are disturbing to seabirds. (Fjeld et al., as referenced in Chardine and Mendenhall, 2003) Breeding murres and eiders appear to be sensitive to this type of disturbance. Murres do not build nests but rather incubate their eggs on their feet; therefore, overflight noises may produce panic flights, leading to egg loss.

During breeding and nesting periods birds may be less likely to flush from their nests for long periods of time. Monitoring studies of birds during the breeding season indicate that adults respond to Space Shuttle noise by flying away from the nest, but they return within two to four minutes.

Noise associated with launches may disrupt critical nesting and migratory points for birds in the Deciduous Forest and Chaparral Biomes, which are common migration corridors for many species. Efforts at reducing noise interference are already underway to protect the endangered Red-Cockaded Woodpecker in the Southeast U.S., where it is estimated that nearly a quarter of the remaining Red-Cockaded Woodpecker population resides on 16 military installations. (Delaney et al., 2002) Birds located in other biomes may also be impacted by launch activities and the extent of impact would be determined based on site-specific considerations.

Noise level thresholds for impact to marine life in general and marine mammals in particular, are currently the subjects of scientific studies. Because different species of marine mammals have varying sensitivities to different sound frequencies, and the species may be found at different locations and depths in the ocean, it is difficult to generalize sound impacts to marine mammals from booster launches. Should consensus emerge from scientific analyses about the effects of noise on underwater marine mammals, it would be possible to predict the consequences of particular sonic boom contours on marine mammals in the area.

According to analysis provided in the U.S. Navy's *Point Mugu Sea Range Environmental Impact Statement (EIS)/Overseas EIS* (2002), brief transient sounds such as sonic booms are unlikely to result in significant adverse effects to pinnipeds or whales in the water. Pinnipeds seem tolerant of noise pulses from sonic booms, although reactions may occur.

Temporary displacement, less than one or two days, is considered a less than significant impact. Baleen whales (humpback, gray, and bowhead) have often been observed behaving normally in the presence of loud noises, such as distant explosions and seismic vessels. Most gray and bowhead whales show some avoidance of areas where these noises have pressures exceeding 170 dB. (U.S. Department of the Navy, 2002, as referenced in U.S. Army Space and Missile Defense Command, 2003)

Launch emissions from pre-fueled and non-pre-fueled liquid propellant boosters would have the potential to impact biological resources, but the impact would be minimal. HCl and Al_2O_3 emitted during launches of solid propellant boosters can harm plants and wildlife. Studies indicate that low-level, short-term exposure to HCl, as would be the case in booster launches, would not cause significant damage to vegetation or wildlife. Animals and birds passing through the exhaust plume may be exposed to levels of HCl that would irritate their eyes and respiratory systems. (FAA, 1996, as referenced in U.S. Army Space and Missile Defense Command, 2002a) Al_2O_3 has a very low toxic potential. HCl and Al_2O_3 do not bioaccumulate; and therefore, no effects on the food chain would be expected. Surface water including wetlands could be impacted by the presence of hydrochloric acid, which could lower the pH and have a negative effect on species relying on the wetlands.

Land Operating Environment. Launch activities from land-based operations that take place in previously disturbed areas would not be expected to adversely affect plant species. Launch areas are typically cleared of all vegetation and either covered with a layer of course gravel or left bare. (Cortez III Environmental, 1996) However, fire from a launch mishap at the launch site could impact plant species that may be present. Any fire would be extinguished quickly, where possible, minimizing impacts to vegetation remaining in the area. The risk of fires from launch activities is particularly prevalent in the Chaparral and Tropical Biomes, which are prone to wildfires.

Sea Operating Environment. Pollutants would be present in the exhaust plume from boosters launched from sea platforms that could threaten wildlife near the point of the sea launch. However, these pollutants would be produced in trace quantities and would not have measurable effects on biological resources.

Postlaunch Activities

Impacts of launch debris on biological resources are discussed below on land versus those impacts of debris falling into water.

Launch Debris Hitting Land. The amount of ground disturbed for each booster or kill vehicle impact would be less than 0.2 hectares (0.5 acres). (U.S. Army Space and Missile Defense Command, 2002c) Restoration of impact sites that are currently used for booster or kill vehicle impacts, if deemed necessary, would be conducted on a case-by-case basis

in coordination with the appropriate officials. Because threatened and endangered plant and animal species tend to be widely scattered and occupy small surface areas, the probability of a booster striking an individual of a federally listed, threatened, or endangered species is remote.

New impact areas for boosters or kill vehicles could be created for specific missions. Selection of a new impact area would be coordinated with the appropriate range personnel to avoid or minimize potential harm to protected species. Effects to biological resources from impacts on a new area would be similar to those described above for impacts on existing areas.

Recovery of booster and kill vehicle debris, if required, would be conducted in accordance with the launch site's existing procedures. These procedures outline steps to be taken to avoid known sensitive areas. Off-road vehicle recovery operations would be used only if necessary and would be coordinated with the appropriate responsible officials. Recovery by vehicle would be limited to the minimum number of vehicles necessary to complete the operation. If necessary, light-lift helicopters could be used to recover debris in rough terrain. Aircraft, particularly helicopters, are loud and produce sounds that might disturb wildlife. Low altitude helicopter flights, which are known to cause panicky reactions in some wildlife species, would be intermittent, would involve gradual descents when necessary, and would then return to altitudes that would avoid further startling effects.

In the unlikely event of flight termination or catastrophic missile failure, the impact of debris on land areas may damage vegetation and wildlife. In the case of flight termination or missile failure, debris and residual propellant could result in a fire that could damage vegetation and wildlife. However, impact areas would generally be cleared of vegetation, minimizing the potential for impact to biological resources due to fires. Hazardous debris, if any, would be recovered as quickly as possible.

Launch Debris Hitting Water. Debris falling into water has the potential to cause non-acoustic effects to biological resources. These effects include physical impact by falling debris, entanglement in debris, and contact with or ingestion of debris or propellants.

Boosters hitting the ocean surface would impart a considerable amount of kinetic energy to the ocean water upon impact. Interceptors would hit the water with speeds of 91 to 914 meters (300 to 3,000 feet) per second. The shock wave from their impact with the water would be similar to that produced by explosives. Depending on the water depth, strong waves from the impact may detach kelp strands from the sea floor. During successful missions, boosters would impact in the deep open ocean waters. At close ranges, injuries to marine mammal internal organs and tissues would likely result.

However, the density of marine species including marine mammals generally decreases, and the corresponding probability of impact decreases, as the distance from the shore increases. Injury to any marine mammal by direct impact or shock wave impact would be extremely remote (less than 0.0006 (6 in 10,000) marine mammals exposed per year). (U.S. Department of the Navy, 2002b)

Impacts to marine biological resources from releases of residual propellants from liquid propellant boosters would not be significant. The natural buffering capacity of sea water and the strong ocean currents would neutralize the reaction to any release of the liquid propellants. Impacts to water quality from a direct release to water are described in the hazardous waste section.

The parts of solid rocket motor propellant expelled from a destroyed or exploded rocket motor that fall into the ocean would most likely sink to the ocean floor at depths of thousands of meters. At such depths, the propellant parts would be located away from feeding marine mammals. (U.S. Department of the Navy, 1998 as referenced in U.S. Army Space and Missile Defense Command, 2003) Therefore, marine animals would not be impacted from ingesting the solid propellant.

Geology and Soils

Prelaunch Activities

There would be no impacts to geology and soils from prelaunch activities for pre-fueled liquid and solid propellant boosters. Fueling of non-pre-fueled liquid propellant boosters would be conducted using appropriate impermeable barriers. (U.S. Army Space and Missile Defense Command, 2002c) Adherence to these procedures would minimize the potential for spills and any impacts to soils.

Launch/Flight Activities

Impacts to geology and soils are discussed separately below for land, sea and air operating environments.

Land Operating Environment. Potential geology and soils impacts from ground launches would be minor. Emissions that occur above the mixing height or above the troposphere would not affect geology and soils.

Soils that are strongly leached (removed of nutrients, including calcium) and are therefore acidic could be adversely affected by the addition of hydrochloric acid produced when HCl interacts with water in humid biomes further increasing soil acidity. This could occur in the Arctic Tundra, Sub-Arctic Taiga, Savanna, Mountain and parts of the Deciduous Forest, and Tropical Biomes.

The intensity of the acidic effect is a function of the amount of calcium carbonate in the soils. Calcium carbonate in some soils including those in the Grasslands and Deciduous Forest and some limestone rich portions of the Tropical Biome have nearly unlimited buffering capacities and would likely prevent emissions produced from solid boosters from affecting geology and soils. (EPA, 2003g) Therefore, no significant impacts to geology and soils would be expected.

The Chaparral and Desert Biomes are unlikely to produce hydrochloric acid as a result of launches of solid propellant boosters and therefore soils in these biomes are unlikely to be affected by increased acid deposition. Although overall impacts to geology and soils from launch activities are expected to be minor, in areas where launches have not previously occurred, such as the U.S. Mountain Biome, the exhaust ground cloud could impact areas not previously disturbed by launch activities. The specific impacts to these areas would need to be analyzed as appropriate.

Air Operating Environment. Impacts to geology and soils from air-based launches would be minor because ignition of the booster would occur several thousand feet above ground level. Emissions from air launches of boosters would have a smaller effect on geology and soil resources than land launches because the emissions would be at a greater altitude and would, therefore, be subject to greater dispersion and dilution prior to reaching the ground.

Sea Operating Environment. No impacts to geology and soils would be expected from launches from sea-based platforms due to the depth of the ocean in areas from which sea launches would operate.

Postlaunch Activities

Impacts to geology and soils from launch debris hitting land versus falling into water are discussed separately below.

Launch Debris Hitting Land. The debris from boosters and kill vehicles could physically impact the ground surface and overlying soils, but there would be no impact expected on geologic resources. Land surface damage from debris would be variable and determined by impact energy, soil compressibility, presence of water, and altitude from which the debris fell. (U.S. Army WSMR, 1998) The impact of the debris may result in ground depressions up to six meters (20 feet) deep. The extent of immediate physical disturbance to the soil from debris impact is likely to be less than 0.2 hectares (0.5 acres).

Debris recovery, if required, would be limited to necessary vehicles and off-road access would follow the same entry route, to the extent possible, to complete the recovery operations with minimal disturbance to soils. (U.S. Army WSMR, 1998)

Residual propellants may be released upon booster or kill vehicle impact. If the propellants burn on impact, fire containment activities could also cause minor impacts to the soil. If vegetation were damaged, then wind and water erosion could both increase.

If the residual IRFNA or unsymmetrical dimethyl hydrazine in a pre-fueled liquid propellant booster do not explode or burn at impact, then they would most likely be deposited on the ground. The IRFNA would volatilize into the atmosphere. Hydrazine fuel would slowly dissipate from surface soils within 24 hours. Hydrazine fuels buried in an impact crater created by the debris would dissipate over several months and would not significantly impact geology or soils. (Cortez III Environmental, 1996)

If the residual propellants from non-pre-fueled liquid propellant boosters do not explode or burn at impact, then they would most likely be deposited on the ground. The nitrogen tetroxide oxidizer would volatilize into the atmosphere. Any residual nitric acid would react with alkaline soils resulting in the deposition of nitrates that would act as a fertilizer and would not appreciably affect soils. Hydrogen peroxide oxidizer deposited on the ground would decompose into water and oxygen within several hours. Kerosene or JP-8 fuel deposited on the ground would be absorbed by the soil. Personnel at the debris impact site would follow standard operating procedures to determine whether soil remediation or removal and treatment and disposal actions are required.

Launch Debris Hitting Water. No impacts to geology and soils would be expected from debris falling into the ocean due to the depth of the ocean where debris would impact. Inert pieces of debris would be deposited in the ocean and would consist of aluminum, steel, graphite composite, plastic, ceramic, and rubber. These materials would likely sink to the ocean floor; however, they would be unlikely to impact geology and soils in ocean areas.

Hazardous Materials and Hazardous Waste

Prelaunch Activities

The types of hazardous materials used and waste generated during prelaunch, launch/flight, and postlaunch activities would be similar to those currently used and generated at military installations. Accidental releases of hazardous materials would be contained in accordance with site-specific spill plans. Temporary storage tanks and other facilities for the storage of hazardous materials would be located in protected and controlled areas. Activities would be conducted to comply with site-specific spill prevention, control and countermeasure (SPCC) plans, such as an Oil Discharge Prevention and Contingency Plan and a Storm Water Pollution Prevention Plan (SWPPP). (U.S. Army Space and Missile Defense Command, 2002d) Any spill of a hazardous material or hazardous waste that might occur could be quickly remediated in

accordance with a Storm Water Pollution Prevention Plan and SPCC plan that would be developed for each site.

Should it become necessary to remove the propellants from a pre-fueled liquid propellant booster, the propellant would be drained into empty bulk liquid propellant containers stored at the fueling location. (U.S. Army Space and Missile Defense Command, 2002c) The defueled oxidizer tank would be flushed with deionized water, and the fuel tank would be flushed with ethyl alcohol. The booster would be transported back to the missile assembly building for reuse or returned to an appropriate facility. Emergency response planning would be incorporated into the operations requirements to minimize any impacts due to an unplanned release of hazardous materials. Therefore, no significant impacts would be expected.

Non-pre-fueled liquid propellant boosters could be fueled at the launch location, provided there is sufficient space, or at a fixed, permanent facility. Fuel and oxidizer would be transported separately to the loading location and loaded at different times. Spill containment for the propellant transfer operation could be provided by a temporary containment system that is impervious to each particular fuel and oxidizer. One set of temporary containment barriers would be used for fuel, and a second set would be used for oxidizer. (U.S. Army Space and Missile Defense Command, 2002c) After completion of the transfer operations, the transfer equipment would be flushed to decontaminate it. Flushing the fuel transfer system would generate approximately 208 liters (55 gallons) of ethyl alcohol with approximately 40 grams (1.4 ounces) of fuel in solution. Flushing the oxidizer transfer system with deionized water would generate approximately 4,164 liters (1,100 gallons) of neutralized deionized water and oxidizer rinsate (less then 1 percent) and would result in the release of approximately five grams (0.2 ounces) of nitric oxide to the atmosphere. The material generated from flushing the propellant transfer systems would be handled as hazardous waste and would be disposed via appropriate procedures using permitted disposal facilities. Although propellant quantities and fueling systems have not been defined for all non-pre-fueled liquid propellant boosters, it is anticipated that similar materials would be generated when flushing hydrogen peroxide oxidizer and hydrocarbon fuel. Flushing nitrogen tetroxide oxidizer would involve similar methods and materials generated as IRFNA.

Should it become necessary to remove the propellants from the non-pre-fueled liquid propellant booster, the propellant would be transferred into empty bulk liquid propellant containers stored at the fueling location. (U.S. Army Space and Missile Defense Command, 2002c) The propellant containers would then be transported to the respective propellant storage areas for reuse in the next mission. The defueled oxidizer tank would be flushed with deionized water and the fuel tank would be flushed with ethyl alcohol as described above. The booster would be transported back to the missile assembly building for reuse or returned to an appropriate facility.

The fuel and oxidizer tanks in kill vehicles would be installed at the test site. Spill containment and propellant removal procedures would be similar to those described above for non-pre-fueled liquid propellant boosters.

There would be no impacts from prelaunch activities for solid propellant boosters.

Launch/Flight Activities

Launch activities would produce the same hazardous materials and hazardous waste in all biomes considered in this PEIS. Launches would potentially increase the hazardous waste generated at the launch sites. However, this increase in hazardous waste would not overburden the various facilities' hazardous waste management programs, and only minimal impacts would be anticipated. During a nominal launch there would be no hazardous materials or hazardous waste impacts from the launch/flight of boosters or kill vehicles.

Postlaunch Activities

Impacts from hazardous materials and hazardous waste launch debris are addressed separately below on land versus in water.

Launch Debris on Land. Debris from boosters and kill vehicles and residual propellant would be handled in accordance with the appropriate spill contingency plan for the launch location/debris impact site. These plans establish responsibility, outline personnel duties, and provide resources and guidelines for use in the control, clean up, and response to spills.

Entry to the debris impact site would be restricted to trained hazardous material response personnel until the area is determined to be safe. All debris would be tested to determine if it is hazardous waste. Hazardous waste would be disposed via permitted procedures. For a nominal flight, liquid propellant boosters would contain unburned propellant upon impact within the planned impact area. The amount of propellant remaining in the booster would vary depending on the particular mission objectives (i.e., distance flown and fuel burned).

During nominal flights of solid propellant boosters, most of the solid propellant would be expended. Debris would include structural material and batteries. These materials would be inert and would not have any significant impacts. Flight termination or catastrophic failure of the booster would result in the deposition of structural material and battery debris and any residual propellant. Some of the potentially hazardous material contained in the batteries or propellants would likely be consumed during the termination or failure. It is not expected that the remaining debris would pose a significant impact.

Launch Debris in Water. NASA has conducted evaluations of the effects of missile systems deposited in sea waters. The studies determined that materials would be rapidly diluted, and except for areas in the immediate vicinity of the debris, would not be found at concentrations identified as causing any adverse effects. This applies to debris deposited either as a result of successful or unsuccessful intercepts, or due to in-flight malfunction or flight termination along the flight corridor. Eventually, all hazardous materials falling into the ocean would become diluted and would cease to be of concern. NASA determined that the release of hazardous materials aboard missiles into sea waters would not be significant. (NASA, 1973 as referenced in U.S. Army Space and Missile Defense Command, 2003) Therefore, no significant impacts to the ocean environment would be expected from postlaunch activities involving liquid propellant missiles.

During flight termination or catastrophic missile failure of solid propellant boosters, pieces of unburned propellant could be dispersed over an ocean area of up to several kilometers. Once in the water, ammonium perchlorate could slowly leach out and would be toxic to plants and animals. In freshwater at 20^{o}C (68^{o}F), it is likely to take over a year for the perchlorate contained in solid propellant to leach out into the water. (Lang et al., 2000, as referenced in U.S. Army Space and Missile Defense Command, 2003) Lower water temperatures and more saline waters would likely slow the leaching of perchlorate from the solid propellant into the water. Over this time, the perchlorate would be diluted in the water and would not reach significant concentrations. (U.S. Army Space and Missile Defense Command, 2003)

Health and Safety

Prelaunch Activities

The handling and assembly of booster components are typically accomplished within enclosed buildings. These activities would adhere to applicable laws and regulations including the Range Commanders Council Standard 321-02, which establishes limits for risk to human health and safety. These analyses would take into account installation-specific and test-specific safety tolerances (range hazard areas).

Prelaunch activities for pre-fueled liquid and solid propellant boosters would not have any impact on health and safety. All liquid propellant booster fueling procedures for non-pre-fueled liquid propellant boosters would be approved for the site where the activity is to occur, and associated emergency response plans would need to be reviewed before beginning activities to ensure protection of health and safety. Total oxidizer and fuel vapor emissions would vary depending on the propellant transfer equipment used and how it is assembled. It is anticipated that only very small amounts of oxidizer vapors would be released to the atmosphere during the oxidizer transfer operation. A negligible amount of fuel vapors would also be released into the atmosphere during fuel transfers. Exposure to liquid propellants resulting from fueling activities would be minimal. The

existing condition in several biomes would preclude fueling emissions from impacting health and safety of workers; this would be true in biomes where wind conditions would rapidly disperse emissions. Windy conditions are likely in the Sub-Arctic Tundra Biome.

Analysis conducted using the U.S. Air Force Toxic Corridor Model computer model indicated potential exceedances of health standards as shown in Exhibit 4-9. Actual hazard distances would depend on the propellant, the amount released, meteorological conditions, and emergency response measures taken. Standard operating procedures would be developed and would include personal protection equipment procedures and distances at which it would be safe to establish fueling operations area boundaries. Establishment of and adherence to these procedures would minimize the potential health and safety hazards to personnel in the unlikely event of an unplanned propellant release. The low likelihood of such an occurrence and the implementation of approved emergency response plans would limit the impact of such a release. People located at distances in excess of the exceedance distance would not be exposed to health and safety impacts from prelaunch fueling activities.

Exhibit 4-9. Potential Exceedances Due to Accidental Oxidizer or Fuel Leak to Air During Fueling Activities

Propellant	Health Standard	Standard Limit	Exceedance Distance
IRFNA	OSHA Permissible Exposure Limit (PEL)[a]	2 parts per million (ppm) (5 milligrams per cubic meter (mg/m^3))	34 meters (112 feet)
	National Institute for Occupational Safety and Health (NIOSH) Short Term Exposure Limit (STEL)[b]	4 ppm (10 mg/m^3)	20 meters (66 feet)
	Immediately Dangerous to Life and Health (IDLH)[c]	25 ppm (65.5 mg/m^3)	Not Exceeded
Hydrogen Peroxide	OSHA PEL	1 ppm (1.4 mg/m^3)	212 meters (696 feet)
	NIOSH STEL	1 ppm (1.4 mg/m^3)	212 meters (696 feet)
	IDLH	75 ppm (105 mg/m^3)	14 meters (46 feet)
Nitrogen Tetroxide	American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV)[d]	3 ppm (5.4 mg/m^3)	310 meters (1,017 feet)
	ACGIH STEL[b]	5 ppm (9 mg/m^3)	227 meters (746 feet)
	IDLH	75 ppm (135 mg/m^3)	103 meters (336 feet)
Hydrazine	OSHA PEL	1 ppm (1.31 mg/m^3)	117 meters (383 feet)

Exhibit 4-9. Potential Exceedances Due to Accidental Oxidizer or Fuel Leak to Air During Fueling Activities

Propellant	Health Standard	Standard Limit	Exceedance Distance
	ACGIH STEL	0.1 ppm (0.131 mg/m^3)	36 meters (118 feet)
	IDLH	50 ppm (65.5 mg/m^3)	Not Exceeded

Source: Modified from U.S. Army Space and Missile Defense Command, 2002c

Notes:

[a] The OSHA PEL is the level of exposure that must not be exceeded when the exposure is averaged over an 8-hour workday and a 40-hour workweek in the workplace.

[b] The NIOSH STEL (or OSHA STEL or ACGIH STEL) is the level of exposure that must not be exceeded at any time during a workday when the exposure is averaged over 15 minutes.

[c] The IDLH is the level of exposure (not time-weighted) above which it is anticipated a person would suffer life-threatening or irreversible health effects or other injuries that would impair them from escaping the hazardous environment.

[d] The ACGIH TLV is an average value of exposure over the course of an 8-hour work shift.

[e] Exceedance Distance-Average of U.S. Air Force Toxic Corridor model results for 15-minute and 30-minute averaging time and multiple stability classes.

Boosters could arrive at the test range with the kill vehicle attached, or the booster may be shipped separately from the kill vehicle. In either case, the fuel and oxidizer tanks would be installed in the kill vehicle at the test site. If the booster is shipped separately from the kill vehicle, the kill vehicle would be mated to the booster in a missile assembly building at the launch facility. These structures are commonly used for these types of activities and no impacts to health and safety would be expected from the mating and assembly process. (U.S. Army Space and Missile Defense Command, 2003)

Launch/Flight Activities

Launch activities would produce the same impacts on health and safety in all of the biomes considered in this PEIS. Potential impacts to health and safety include exposure to explosives, contact with launch debris, and exposure to noise produced during launch. Because launches would take place on facilities with restricted access, members of the public would not be exposed to these hazards.

Appropriate health and safety standard operating procedures would be developed to protect personnel. Every reasonable precaution would be taken during the planning and execution of a launch to prevent injuries.

A written procedure for all explosive activities is required and must be approved by the appropriate range authorities. Established procedures to prohibit access to restricted areas would be followed. The restricted areas are based upon the probability of potential hazards involved with malfunction during launches and would include

- The impact limit line, which sets the boundary protection line for all non-mission essential personnel;
- The launch caution corridor, an area limited to essential personnel;
- The LHA, an area around the launch point limited to essential personnel in hardened facilities; and
- The stage or booster impact area.

Impact zones for each launch would be delineated based on detailed launch planning and trajectory modeling, which would include analysis and identification of a flight corridor. Flights would be conducted when trajectory modeling verifies that launch-related debris would be contained within predetermined areas, all of which would be located away from inhabited land and populated areas.

Launch-related personnel that would be exposed to noise in excess of applicable standards including OSHA regulation 1910.95 would be required to wear appropriate hearing protection, which would reduce the noise levels to prescribed health and safety levels.

Postlaunch Activities

There is the potential for impact of debris from boosters and kill vehicles at any point along the flight corridor due to missile malfunction and/or termination of a missile flight by the FTS. The resulting debris would follow a ballistic trajectory and would impact in designated impact areas either on land or in the ocean. Because an exact point of termination cannot be determined, the potential effects footprint is determined by considering the limits of debris fallout based on destruction of a test missile at the boundaries of the acceptable flight corridor, along with additional flight time based on the time required to initiate the FTS. The possibility of debris hitting the ground or water outside the designated impact area is remote; and therefore, safety impacts of flight termination would not be significant. Debris modeling and analysis would be conducted for specific proposed activities as appropriate.

Launch Debris on Land. Procedures would be developed to establish appropriate debris recovery procedures, as necessary, and would include personal protective equipment and determination of appropriate recovery zone hazard boundaries. Therefore, no health and safety impacts would be expected from postlaunch activities.

Exhibit 4-10 indicates the results of an analysis using the U.S. Air Force Toxic Corridor Model to determine distances at which various health standards could be exceeded based on the release of residual propellant at the debris impact area. The analysis was conducted for non-pre-fueled liquid propellant boosters assuming 473 liters (125 gallons) of the remaining oxidizer and 265 liters (70 gallons) of the remaining fuel were released

to the atmosphere. People located at distances in excess of the exceedance distance would not experience impacts to health and safety from postlaunch activities.

Exhibit 4-10. Potential Exceedances Due to Accidental Oxidizer or Fuel Leak at the Booster Impact Site

Propellant	Health Standard	Standard Limit	Exceedance Distance
Inhibited Red Fuming Nitric Acid (IRFNA)	OSHA PEL	2 ppm (5 mg/m^3)	213 meters (699 feet)
	NIOSH STEL	4 ppm (10 mg/m^3)	140 meters (458 feet)
	IDLH	25 ppm (65.5 mg/m^3)	50 meters (164 feet)
Hydrogen Peroxide	OSHA PEL	1 ppm (1.4 mg/m^3)	195 meters (639 feet)
	NIOSH STEL	1 ppm (1.4 mg/m^3)	195 meters (639 feet)
	IDLH	75 ppm (105 mg/m^3)	11 meters (36 feet)
Nitrogen Tetroxide	ACGIH TLV	3 ppm (5.4 mg/m^3)	1,074 meters (3,525 feet)
	ACGIH STEL	5 ppm (9 mg/m^3)	740 meters (2,429 feet)
	IDLH	75 ppm (135 mg/m^3)	274 meters (899 feet)
Hydrazine	OSHA PEL	1 ppm (1.31 mg/m^3)	462 meters (1,515 feet)
	ACGIH STEL	0.1 ppm (0.131 mg/m^3)	123 meters (404 feet)
	IDLH	50 ppm (65.5 mg/m^3)	13 meters (44 feet)

Source: Modified from U.S. Army Space and Missile Defense Command, 2002c

Launch Debris in Water. Booster trajectories would be established to preclude potential water impacts in heavily trafficked ocean areas. Notices to Mariners (NOTMARs) would be issued as appropriate to advise mariners of the projected impact area. In the event of a flight termination, the possibility of debris impacting a sea vessel would be remote, and therefore safety impacts of flight termination would not be significant.

During flight termination or catastrophic missile failure of solid propellant boosters, pieces of unburned propellant could be dispersed over an ocean area of up to several kilometers. Once in the water, ammonium perchlorate could slowly leach out. In 1985, perchlorate was detected in wells of California Superfund sites; however, perchlorate contamination was not detected nationwide until 1997. Currently there are no Federal drinking water standards for perchlorate. The EPA has the responsibility to establish national drinking water standards and has issued draft risk assessments of perchlorate. These assessments have been criticized because it has been suggested that the findings are based on flawed scientific studies and that not all available data were considered and incorporated. Because of these controversies, the EPA, DoD, DOE, and NASA asked the National Research Council (NRC) to independently assess the adverse health effects of perchlorate ingestion from clinical, toxicological, and public health perspectives. The NRC was also tasked to review the scientific literature and findings from the EPA's 2002

draft risk assessment, *Perchlorate Environmental Contamination: Toxicological Review and Risk Characterization*.

Although there are no Federal drinking water standards for perchlorate several states have proposed interim guidance levels or goals for perchlorate levels in drinking water. In March 2004, the State of California Office of Environmental Health Hazard Assessment established a public health goal for perchlorate in drinking water of 6 parts per billion. (California Office of Environmental Health Hazard Assessment, 2005) The NRC study considered the health impacts from perchlorate exposure. The results of this study and an overview of additional relevant studies on the impacts of perchlorate on human health and the environment are discussed in Appendix M of this PEIS.

Perchlorate can impact thyroid function because it inhibits the transport of iodide into the thyroid. The NRC study examined short-term studies that found that to negatively impact the thyroid, iodide uptake by the body would need to be reduced by at least 75 percent for months or longer. The NRC reported results of longer term studies that found that to cause hypothyroidism in adults would require them to be given more than 0.40 milligrams per kilogram (mg/kg) of perchlorate (assuming a body weight of 70 kilograms). However, in pregnant women, infants, children, and people with low iodide intake or pre-existing thyroid dysfunction, the dose required to cause hypothyroidism may be lower.

Epidemiologic studies considered by the NRC have examined the relationship between perchlorate exposure and thyroid function and thyroid disease in newborns, children, and adults. The NRC concluded that no studies have investigated the effect of perchlorate exposure in vulnerable groups, such as low birth weight or preterm infants. In addition, these studies have not considered the impacts to the offspring of mothers who were exposed to perchlorate and had a low iodide intake. Finally, adequate studies have not been completed of maternal perchlorate exposure and neurodevelopmental outcomes in infants.

The NRC study considered the applicability of animal toxicology studies to human health and found that although studies in rats provide useful qualitative information on potential adverse effects of perchlorate exposure, they have limited applicability for quantitatively assessing human health risks associated with perchlorate exposure.

The NRC study also reviewed EPA's findings presented in the 2002 perchlorate risk assessment. A primary purpose of EPA's perchlorate risk assessment was to calculate a reference dose (RfD). The NRC study did not agree with the basis of the EPA's study, which relied on animal data. The NRC reviewed both human and animal data and found that the human data formed a better basis for risk assessments. The EPA study's draft RfD for perchlorate was 0.00003 mg/kg per day and the NRC study recommended an RfD of 0.0007 mg/kg per day. The NRC stated that this value is supported by other

clinical studies, epidemiologic studies, and studies of long-term perchlorate administration. The NRC report concluded that the proposed RfD of 0.0007 milligrams per kilogram per day should protect even the most sensitive populations. The EPA has established an official RfD of 0.0007 mg/kg/day of perchlorate consistent with this recommended RfD, which translates into a Drinking Water Equivalent Level of 24.5 ppb.

Noise

Prelaunch Activities

Prelaunch activities including evacuation and road closure activities and storing boosters, propellants, and kill vehicles would have no impact on noise.

Launch/Flight Activities

Launch activities would produce the same noise levels in all of the biomes considered in this PEIS. The potential for impact would depend on the specific launch location. Three possible issues must be addressed to determine potential noise impacts, including personnel safety, public safety, and public annoyance. The impact of noise from launches on biological resources is addressed in Biological Resources. Launches would not add new types or levels of noise to the current noise environment at existing launch sites. Noise levels produced by BMDS launches would be similar to past and current noise levels at launch sites. Launches would be relatively short noise events during which all personnel would be located in various control or blockhouses and therefore would be protected from noise by the sound attenuation provided by the building's construction. Zones in the operations area with high noise levels would be designated off-limits to non-essential personnel. Entry into these zones would be prohibited except to personnel wearing hearing protection that would reduce noise.

Sonic booms may be generated during launch or booster reentry. Each booster would propagate a unique sonic boom contour depending upon its mass, shape, velocity, and launch or reentry angle, among other variables. Areas affected by a sonic boom could extend up to several miles on each side of the focal point of the sonic boom. Sonic booms may produce overpressures as high as 8 to 16 pounds per square foot, but this would be of very short duration, lasting up to several milliseconds. (U.S. Army Space and Strategic Defense Command, 1994a) These levels of sonic booms can have minor effects on physical structures (glass failure, plaster may crack, etc.) but are not strong enough to cause injury to people.

Air Operating Environment. Noise generated by the booster launched from an air platform would reach the Earth's surface. Prior analyses of air-launched boosters showed that an Air Drop vehicle launched from an altitude of approximately 5,000 feet above MSL would generate approximately 115 dBA at ground level directly below the launch

point. (BMDO, 1998) The noise levels that reach the ground will vary depending on the altitude and attitude at which the booster is launched. This noise would decrease rapidly as the launch altitude increases; thus, launch noise would be brief.

Sea Operating Environment. Launches from sea platforms in the BOA would have fewer noise impacts because of the distance of the sea operating environment from population centers. Essential personnel would be located in an area of the sea launch environment that is protected from the noise generated during launch. Non-essential personnel would be moved to a safe distance and would be protected from the noise generated during launches. Personnel that may be exposed to loud noises would be required to wear hearing protection, such as earplugs or earmuffs, which would reduce noise levels to prescribed health and safety levels.

Postlaunch Activities

Impacts of noise from launch debris recovery activities on land are discussed below.

Launch Debris on Land. Vehicles used for booster and kill vehicle debris recovery operations (trucks and helicopters) on land would produce noise. Each recovery operation would be expected to last less than one day; thus, noise associated with debris recovery would not be a constant occurrence. Helicopter flight helmets would provide the required noise attenuation for the crew. Noise impacts from debris recovery operations would be minor.

Transportation

Prelaunch Activities

Prelaunch activities including booster fueling, road closure, and evacuations would not impact transportation. Road closures would be implemented in the areas around the launch site and along the expected trajectory. These temporary road closures would be of short duration and would be considered routine occurrences for launch sites. Prominent notices would be posted to notify the general public and local businesses of expected closures. Therefore, impacts on traffic are not expected to be significant. Existing agreements regarding road closures would be followed. These impacts would be the same in all of the biomes considered in this PEIS. Any disruption due to military convoys or roadblocks would be of short duration and would not be expected to have a significant impact on transportation.

Propellants for non-pre-fueled liquid propellant boosters would be transported from the storage facility to the fueling location in accordance with appropriate regulations and would not be expected to pose significant impacts to transportation.

Launch/Flight Activities

Issuance of NOTMARs is standard practice when a launch has the potential to impact marine areas and would allow marine vessels to clear the affected area; thus, launch activities would have no impact on marine transportation

In some biomes there are few roads and much of the transportation in the region occurs by airplane. Therefore, while launches may have little to no impact on ground transportation due to road closures, air transportation may be temporarily affected. NOTAMs would be issued prior to launch events that would notify pilots of proposed airspace closures and would permit pilots to find new routes or to delay their trip until after the airspace is reopened. Impacts to air transportation are discussed above in Airspace.

Postlaunch Activities

Impacts to transportation from debris recovery are addressed separately for land and water below.

<u>*Launch Debris on Land*</u>. Trucks and mobile ground equipment used for debris recovery operations for boosters and kill vehicles would travel both on- and off-road. Debris recovery requires a relatively small number of vehicles and therefore, is not expected to impact traffic or transportation infrastructure.

<u>*Launch Debris in Water*</u>. Debris from boosters and kill vehicles may fall into waters normally occupied by commercial shipping. The majority of international trade uses routes of least distance. The actual debris impact area for boosters and kill vehicles would be small and would depend upon the individual flight path. Prior warning of proposed launch activities through issuances of NOTMARs would enable commercial shipping to follow alternative routes away from the proposed debris impact area.

Water Resources

Prelaunch Activities

Adherence to existing policies and procedures would minimize the impacts from spills related to pre-fueled and solid propellant boosters and kill vehicles. Fueling of non-pre-fueled liquid propellant boosters would be conducted in accordance with approved procedures and all applicable regulations. All fueling would be conducted using appropriate impermeable barriers that would prevent spills from reaching bodies of water.

Launch/Flight Activities

Small amounts of hydrochloric and hydrofluoric acids would be generated from the launch of pre-fueled liquid propellant boosters. These acids could reach surface water if rainfall occurred within two hours of a launch. This is most likely to occur in the Arctic Tundra, Sub-Arctic Taiga, Deciduous Forest, and Mountain Biomes where rain is a frequent occurrence. In addition, hydrochloric acid could be produced in the Sub-Arctic Taiga, Chaparral, Grasslands, and Savanna Biomes when cool and humid conditions exist during launch activities. Given the dry conditions in the Desert Biome it is unlikely that chlorine would be converted to hydrochloric acid. The Tropical Biome is generally humid but the temperatures are not cool enough to convert the HCl produced as a result of launches to hydrochloric acid. In the BOA, the acid produced would be neutralized by calcium carbonate in ocean water. However, exhaust emissions from pre-fueled liquid propellant missiles would not significantly impact water quality.

Launch of solid propellant boosters could result in deposition of small amounts of Al_2O_3 from booster exhaust. This exhaust product could be deposited in surface waters. EPA has determined that Al_2O_3 as found in solid propellant exhaust is nontoxic. (NASA, 1990, as referenced in U.S. Army Space and Strategic Defense Command, 1994a) Al_2O_3 would be hazardous only in acidic biomes (pH less than 5) where it would dissociate into free aluminum cation. (FAA, 1996, as referenced in U.S. Army Space and Missile Defense Command, 2003)

In biomes where rain is a frequent occurrence, launches with solid boosters have an increased likelihood of contributing to acid rain, thereby increasing the amount of HCl deposited in regional surface waters. In areas with low velocity of surface and ground water movement and relatively shallow ground water table it is possible that deposition of acidic water may impact water resources. The potential for and extent of impact would need to be examined in site-specific environmental analysis.

In the absence of substantial surface and ground water bodies, launch exhaust emissions are unlikely to impact water resources. Additionally, in many desert areas, the ground water table is lower than six meters (20 feet) below ground level, which would inhibit contamination from surface pollutants. For example, the evaporation and deposition of dissolved solids in the water for thousands of years has formed a hardpan over much of the Tularosa Basin, which houses an aquifer that underlies WSMR, New Mexico, and Fort Bliss, Texas. The hardpan consists of impermeable silt and clay and aids in preventing pollution of the aquifer from the land surface. It is unlikely that the aquifer could be contaminated from surface seepage from the lower elevations of the basin. This eliminates any direct channeling to the water table. (Carmichael, 1986, as referenced in U.S. Army WSMR, 1991)

Postlaunch Activities

If residual liquid propellants were deposited in surface water (either in the ocean or in lakes or streams), nitric acid would cause a short-term pH change in the water body. The acid would mix with the water and eventually be neutralized and diluted. Hydrogen peroxide in surface water would decompose into water and oxygen within eight hours to 20 days. Kerosene or JP-8 fuel would not mix with the water, but would form a slick on the surface that would stick to surfaces it contacts. Hydrazine fuels would degrade primarily into N_2 gas and water over a period of hours to weeks, with degradation proceeding more rapidly in alkaline waters.

Impacts to water quality from a direct release on land are described in the hazardous waste section above.

<u>*Launch Debris in Water*</u>. In some instances, an early flight termination could result in propellant and debris deposition in water bodies. Some perennial surface waters could be impacted following a flight termination. However, the probability of any individual water body, spring, or creek being directly impacted is extremely low and would be a function of the amount of surface water in the impact area. An early flight termination also could possibly impact in an area of shallower ground water or an aquifer recharge zone. In any of these unlikely events, the appropriate officials would be notified.

In the event of a failure, effluents may enter water bodies if the debris impacts in surface water areas. These effluents could enter underground sources of drinking water in areas where there is a shallow ground water table. However, the release rates of materials that impact surface water would be such that no significant changes in surface water quality would be detectable.

The booster and kill vehicle would consist primarily of inert metal objects that would have little potential to contaminate water bodies. In general, a typical water contamination response would include

- Rendering the booster or debris safe,
- Stopping the flow of oxidizer or fuel,
- Neutralizing the oxidizer in the stream (or body of water) sufficiently far downstream so as to avoid a continuing hazard to water quality,
- Installing surface skimmers and absorptive materials downstream from the lead edge of contamination to collect the fuel,
- Monitoring the pH along the stream to ascertain that a background pH level has been established, and
- Removing all petroleum products from stream surfaces and returning the damaged area to an environmentally sound level.

Orbital Debris

Prelaunch Activities

No orbital debris would be produced from prelaunch activities.

Launch/Flight Activities

Orbital debris could be produced from launch/flight activities in the event of a booster failure while in the exoatmosphere. However, any debris would not be expected to remain in orbit for more than a short time, followed by deorbiting and eventual burn-up during reentry of the Earth's atmosphere.

Postlaunch Activities

A failure of a booster in the exoatmosphere may generate orbital debris. The type of orbital debris produced from a booster failure would be similar to that produced from a high altitude successful intercept. However, the amount of debris from a booster failure would be less than that produced from an intercept. The impacts of orbital debris from intercepts are discussed in Section 4.1.2.10 and were found to not pose significant impacts. Therefore orbital debris from a booster failure would similarly not pose significant impacts.

4.1.1.3 Sensors - Radars

As described in Exhibit 4-3, the analysis for radars is based upon impacts from the activation of the radar.

Air Quality

Activation emissions from radars would be limited to exhaust produced by generators. Impacts related to generator emissions are discussed in Support Assets. These impacts would be the same in all of the biomes considered in this PEIS.

Airspace

During activation of land-based radars, NOTAMs would be issued and pilots would be restricted from EMR hazard areas. NOTAMs would be sent in accordance with the conditions of the directive specified in Army Regulation 95-10, Operations to notify aircraft of EMR hazard areas during the activation of radars. Airspace restrictions would be short-term events and would not pose a significant impact on available airspace. Sufficient notice of restricted areas would be provided to allow pilots to select alternate flight paths to avoid restricted areas.

The activation of radars in the Sub-Arctic Taiga Biome may impact small civilian aircraft, which frequently transit the biome at low altitudes. Because many remote civilian airports within this biome do not have operating control towers, some aircraft pilots may be required to upgrade their communication equipment (at their own expense) to ensure that they are aware of activation activities and areas that must be avoided. Civilian aircraft would be required to contact local range control towers when transiting restricted airspace. The controllers would then be able to advise civilian pilots as to their proximity to hazard areas during activation of radars. (U.S. Army Space and Missile Defense Command, 2000) Other biomes including Arctic Tundra and the BOA are unlikely to experience impacts because small civilian aircraft would not readily occur in these regions. The Deciduous Forest, Chaparral, Grasslands, Desert, Tropical, Savanna, and Mountain Biomes are unlikely to experience impacts because these biomes are more likely to have operational control towers that could communicate with civilian aircraft.

For activation activities occurring in international airspace, procedures of the ICAO would be followed. ICAO Document 4444 is the equivalent air traffic control manual to the FAA Handbook 7110.65, Air Traffic Control. Personnel would ensure coordination with the ICAO through the FAA, to issue NOTAMs, locate ships with radar capable of monitoring the airspace, contact all commercial airlines and civil and private airports, and monitor appropriate radio frequencies to minimize potential safety impacts.

During activation of radars in the BOA, at least one Control Area Extension corridor in the BOA would remain available for use by general aviation and commercial air carriers.

Potential interference to aircraft electronic and emitter units (e.g., flight navigation systems and tracking radars) would be examined before activation of radars. A high-energy radiation area would be configured to mitigate potential impacts to aircraft and other potentially affected systems and a notice would be published on the appropriate aeronautical charts, notifying aircraft of the radio frequency radiation area. Boundaries of these radio frequency radiation areas would be configured to minimize impacts to aircraft operations and other potentially affected systems. In addition information would be published in the Airport Facility section of the FAA Airport Guide. Flight service personnel would brief pilots flying in the vicinity about the radio frequency radiation area. Radar operations would be coordinated with FAA and range officials and if possible would be programmed to limit radio frequency emissions in the direction of airways that pass within the potential interference distance.

EMR from radar activation may interact with and adversely affect aircraft operations by disabling or inadvertently initiating vital electronic equipment, including electroexplosive devices on-board aircraft. Electroexplosive devices on aircraft in flight could be illuminated by a radar main beam. Software controls and coordination with military and commercial aircraft controllers would eliminate this potential hazard. (U.S. Army Space and Missile Defense Command, 2003)

The FAA and DoD have standards, such as MIL-STD-464, for EMR interference with aircraft, which would not be exceeded. To operate in an affected area, military aircraft would have to be hardened or protected from EMR levels up to 3,500 volts per meter (peak power) and 1,270 volts per meter (average power). Commercial aircraft must be hardened or protected from EMR levels up to 3,000 volts per meter (peak power) and 300 volts per meter (average power) as mandated by the FAA by Notice 8110.71, Guidelines for the Certification of Aircraft Flying through High Intensity Radiated Field Environments. Radars would not exceed the 3,000 volts per meter power threshold.

Reducing the time on-board electronic equipment is exposed to EMR would lower the average power threshold experienced. (U.S. Army Space and Missile Defense Command, 2003) Commercial aircraft equipment would be affected only if the main beam illuminated the aircraft long enough to affect on-board electronics. Because radars are typically in constant motion, it is highly unlikely that a radar would illuminate an aircraft long enough to interfere with on-board electronics.

Activation impacts from air- and sea-based radars would be similar to those described for land-based radars. Radars located on sea-based operating environments would most likely be located far enough off the coast to not interfere with existing airfield or airport arrival and departure traffic flows. Activation of space-based radars would not be expected to impact airspace.

Biological Resources

Radar activation activities would produce the same impacts on biological resources in all of the biomes considered in this PEIS. The potential for main-beam exposure thermal effects to animals, especially birds, exists from the activation of land- and air-based radars. The *Final Ground-Based Radar Family of Radars Environmental Assessment* (1993) and *Ground-Based Midcourse Defense Extended Test Range Environmental Impact Statement* (2003) analyzed potential impacts on wildlife from EMR. Additional analysis is provided in this PEIS in Appendix N. Potential effects include exposure of birds to the main radar beam, which could result in thermal heating or interference with the navigation of migratory birds, EMR impacts from the COBRA DANE radar operating on Eareckson Air Station on Shemya Island, Alaska, bird collisions with radar and radar equipment, and effects in the near shore environment.

Appendix N evaluates under what conditions a BMDS radar beam could be sufficiently powerful to cause thermal heating or to interfere with the navigational ability of migratory birds. The proposed BMDS radars would operate within five different wavebands: UHF, L, S, C, and X bands. For each of the five bands, the most powerful type of radar operating in that band was evaluated. The representative radar from each band is PAVE PAWS for UHF, COBRA DANE for L-band, Aegis for S-band, MPS-36 for C-band and SBX for X-band.

The conservative analysis presented in Appendix N indicated that there is no concern for birds flying through radar beams emanating from the X-band, C-band and UHF radars. This applies to bird flights perpendicular to or in the direction of stationary beams, as well as for beams in surveillance mode. However, for the L-band COBRA DANE radar, there may be some risk to birds flying at flight altitudes of less than 1,700 meters above the radar, when the beam is elevated between four and fifty degrees above horizontal. This is a worst-case scenario for birds migrating from Alaska along the Pacific Oceanic migration route that might fly parallel to the COBRA DANE radar beam for a portion of their flight. Birds migrating from Alaska to Asia are likely to be flying more perpendicular or at an angle to the radar beam than parallel to the beam. For higher beam elevations and for lower flying birds, migrating birds flying parallel to the beam may not receive exposures above the no-harm reference value.

In Appendix N, MDA has considered mitigation measures to reduce the possible risks to migrating birds. The mitigation measures discussed in Appendix N include

- Evaluating the possibility that the COBRA DANE radar might be tested with stationary beams during spring and fall migrations.
- Evaluating whether the locations where the COBRA DANE radar would be used are in a significant migratory route or near to a migratory stopover, such that large migratory flocks might on occasion pass through the radar beam.
- Considering use of a local Next Generation Weather Radar (NEXRAD) to help evaluate when large flocks might be in the vicinity of the radar if a risk to migratory flocks is deemed to exist, so that the timing of a test does not coincide with particularly large flocks of birds flying close to the radar.

Bird collisions with radars and radar equipment also are a concern. MDA could mitigate this risk by using highly visible paints and a change in brightness of warning lights on the antenna towers and guy wires to minimize the potential for bird collisions with radar equipment. Overall, no significant impacts to birds would be expected from the operation of radars.

Potential impacts on wildlife from the activation of sea-based radars in the near shore environment would include seabirds and shorebirds, including migratory species, striking the antennas, telescopes, and shelters or becoming disoriented due to high intensity lighting at night. To minimize the occurrence of bird strikes, antennas would be raised only as necessary and colorful streamers or other visual indicators could be used to increase visibility to birds, if there is no interference with the operation of the radar. To prevent birds from becoming disoriented, high intensity lighting would be used only when necessary and low intensity lighting would be used whenever possible. Lighting would be adequate for safe working conditions but minimized to the extent practical.

Radar main beams on sea-based operating environments would not be directed toward the ocean surface, which would limit the probability of energy absorption by surface-oriented wildlife. The power density level just below the surface of the ocean where marine mammals may be located would not exceed the PEL for uncontrolled environments. (U.S. Department of the Navy, 2002a, as referenced in U.S. Army Space and Missile Defense Command, 2003) No adverse impact would occur to whales, other marine mammals, or sea turtles found at least 1.3 centimeters (0.5 inch) below the surface. It is also highly unlikely that an individual would be on or substantially above the surface of the water for a significant amount of time within the main beam area during radar activation. Therefore, no impacts are anticipated to whales, other marine mammals, or sea turtles that might be present in the vicinity of the radar.

Previous analysis (U.S. Army Space and Missile Defense Command, 2003) has shown the potential EMR interference distance for fully-populated XBR to be only 19 kilometers (12 miles). Because space-based platforms would be placed in LEO or GEO at altitudes ranging from approximately 160 to 1,600 kilometers (100 to 1,000 miles) for LEO and approximately 35,000 kilometers (21,700 miles) or greater for GEO, it is expected that EMR would not reach Earth; thus, the activation of space-based radars would not be expected to impact biological resources.

Geology and Soils

Radar activation activities would produce the same impacts on geology and soils in all of the biomes considered in this PEIS. Impacts to geology and soils from activation of radars would be limited to accidental spills of diesel fuel from generators used to support the activation of radars. Potential impacts from releases of diesel fuel are discussed in Support Assets.

Hazardous Materials and Hazardous Waste

Radar activation activities would produce the same hazardous materials and hazardous waste impacts in all of the biomes considered in this PEIS. The types of hazardous materials used and waste generated would be similar to those currently used and generated at military installations. Antifreeze and fire suppressants would be used for radar electronic systems. Cooling equipment units would use coolant fluids, such as a mixture of ethylene glycol and water. In addition, radar components and antenna units may require periodic application of petroleum-based lubricating oils. Used petroleum, oil, and lubricants would be generated in smalls amounts are not normally considered hazardous waste (designation varies by state). (U.S. Army Space and Strategic Defense Command, 1993c) All hazardous materials used and hazardous waste generated during the activation of land- and air-based radars would be handled in accordance with applicable regulations. Accidental releases of hazardous materials would be contained in accordance with site-specific spill plans.

Temporary storage tanks and other facilities for the storage of hazardous materials would be located in protected and controlled areas designed to comply with SPCC plans. Hazardous wastes generated during radar activation activities may consist of materials such as waste oils, hydraulic fluids, cleaning fluids, cutting fluids, and waste antifreeze. The minimal quantities of hazardous waste that could potentially be generated would be disposed of in accordance with appropriate waste disposal regulations.

Impacts from hazardous materials and hazardous waste management for sea-based radars would be similar to those described for land- and air-based radars. The U.S. Navy requires that, to the maximum extent practical, ships retain hazardous waste onboard for shore disposal. If hazardous materials are discharged overboard, this must occur more than 370 kilometers (200 nautical miles) from land. Discharging hazardous materials overboard is not standard practice and would only be done in emergency situations. Twenty-five liquid discharges, such as clean ballast, deck runoff, and dirty ballast, from normal operation of military vessels are required to be controlled by installation of control technologies or use of management practices (marine pollution control devices) under the Uniform National Discharge Standard provisions of the Clean Water Act. In compliance with Uniform National Discharge Standards, the sea-based operating environment would incorporate marine pollution control devices, such as keeping decks clear of debris, cleaning spills and residues, and engaging in spill and pollution prevention practices, in design or routine operation.

Health and Safety

Radar activation activities would produce the same impacts on health and safety in all of the biomes considered in this PEIS. Safety precautions for handling, storing and transporting hazardous materials and hazardous waste releases would be followed at sites involved in BMDS activities. Each site would follow spill control and emergency response plans that would provide response actions for cleanup. Sites would maximize on-site and off-site recycling to reduce the need for waste disposal sites and handle or dispose of hazardous materials or wastes in compliance with all applicable laws, regulations, and guidance. (U.S. Army Space and Strategic Defense Command, 1993b)

Prior to activation of radars, an EMR survey would be conducted that considers hazards of EMR to personnel, to fuels, and to ordnance. The analysis would provide recommendations for sector blanking and safety systems to minimize exposures. Appropriate safety exclusion zones would be established before operation, and warning lights to inform personnel when the system is operating and emitting EMR would be installed.

Personnel exclusion areas would be established to protect personnel from potential EMR hazards during radar activation. Personnel not involved in test event activities would not be permitted to enter established hazard zones during the activation of radars. EMR

hazard zones would be established within the main beam's tracking space near emitter equipment. A visual survey of the area would be conducted to verify that all personnel are outside of the hazard zone prior to activation. Safety exclusion zones would also be established around generator wiring and cabling to protect personnel from high voltage exposure.

Potential health and safety hazards associated with the operation of radars were analyzed in previous documents. Two examples of these are *Ground-Based Radar Family of Radars Environmental Assessment* (1993) and *Environmental Assessment for Theater Missile Defense Ground-Based Radar Testing Program at Fort Devens, Massachusetts* (1994). These analyses considered operational requirements and restrictions and range-required safety procedures. It was determined that implementing safety procedures, including establishing controlled areas and limitations in the areas subject to illumination by radars, would preclude any potential safety hazard to either the public or project-related personnel from exposure to EMR.

The analysis method used to evaluate potential impacts of radio frequency radiation is the IEEE Maximum Permissible Exposure (MPE), which defines the maximum time-averaged radio frequency power density allowed for uncontrolled human exposure. The MPE method is independent of body size or tissue density being exposed. EMR hazard zones provide a safety factor 10 times greater than the MPE. MPEs are capped at 5 megawatts per square centimeter for frequencies greater than 1,500 MHz. (IEEE C95.1-1999, Standard for Safety Levels with Respect to Human Exposure to Radiofrequency EM Fields, 3 kilohertz to 300 GHz) General public exposure is typically limited to one fifth of the occupational limits.

At X-band frequencies, the IEEE standard for human exposure is 5.33 megawatts per square centimeter. For radars to have an effect on human health, the beam operating at full power would have to come in contact with a person and remain on them for 7.5 minutes (at 8,000 MHz) or 11.25 minutes (at 12,000 MHz). (U.S. Army Space and Missile Defense Command, 2003) The beam would normally be in motion, which would reduce the likelihood that a person would remain within the most intense area of the beam for any considerable length of time.

In addition to the impacts described above, activation of radars on sea-based operating environments would be coordinated with the FAA, U.S. Coast Guard, and other groups or agencies as appropriate. The implementation of software controls would prevent a radiation hazard zone from occurring on the deck of the sea-based operating environment.

Noise

Radar activation activities would produce the same noise impacts in all of the biomes considered in this PEIS. Noise impacts associated with activation of radars would be limited to noise produced by generators. Impacts related to generator noise are discussed in Support Assets.

Transportation

The activation of radars has the potential to impact air transportation. These impacts are discussed in Airspace. These impacts would be the same in all of the biomes considered in this PEIS.

NOTMARs would be issued in advanced of test events; therefore, commercial marine vessels would be able to choose transportation routes outside of proposed radar activation areas.

Water Resources

Additional personnel would be needed for the activation of radars; these personnel would increase the demand for potable water. An increase in demand could exceed the capacity of the existing infrastructure at some locations. (U.S. Army Space and Missile Defense Command, 2003) This is of particular concern in portions of the Sub-Arctic Taiga, Grasslands, Desert, Tropical, and Mountain Biomes. It is anticipated that additional packaged potable water systems would be installed to meet the demands in areas where access to potable water is limited. Site-specific studies should consider the limited potable water supplies in these areas when analyzing the impacts to water resources from the proposed activation of radars. Other biomes including Arctic Tundra, Sub-Arctic Taiga, Deciduous Forest, Chaparral, and Savanna Biomes are unlikely to experience impacts to water resources. Due to ample ground water supply, it is unlikely that a significant increase in demand would exceed the capacity of existing infrastructure in these biomes.

Impacts to water resources from activation of radars would include potential release of hazardous materials. Materials released from sea-based operating environments would be rapidly diluted and would not be found at concentrations identified as producing any adverse impacts due to the high buffering capacity of sea water in the open ocean. The ocean depth in the vicinity of sea-based radar would most likely be thousands of meters deep, and consequently, any impact from fuel or hazardous material spills would be minimal. From land- and air-based operating environments, impacts from hazardous materials releases would depend on the characteristics of the water bodies in the respective biome. No impacts to water resources would occur as a result of space-based sensors that would be in GEO.

Orbital Debris

No impacts from orbital debris would occur as a result of the activation of land-, air-, and sea-based radars.

Orbiting objects lose energy through friction with the upper atmosphere and various other orbit perturbing forces. Over time, an object may drop into progressively lower orbits and may eventually fall to Earth. As the object's orbital trajectory draws closer to Earth, it speeds up and outpaces objects in higher orbits. Once the object enters the measurable atmosphere, atmospheric drag will slow it down rapidly and cause it either to burn up or deorbit and fall to Earth.

Space-based radars could reenter the Earth's atmosphere due to failure, but would not likely result in significant impacts. Most objects break up and often vaporize under the intense aerodynamic forces and heating that occur during reentry. Most of the objects which reenter would fragment and burn in the upper atmosphere and would make only negligible changes in its chemical composition. An estimated 500 objects and thousands of debris fragments reenter the Earth's atmosphere each year; however, few survive reentry. Out of approximately 3,100 objects from 44 launches between 1956 and 1972, only 100 have survived reentry and been recovered. Even if an object does survive reentry, only one third of the Earth is land area, and only a small portion of this land area is densely populated. The chance of hitting a populated land area upon reentry would be small. (SDIO, 1992)

4.1.1.4 Sensors - Infrared and Optical Sensors

As described in Exhibit 4-3, the analysis for infrared and optical sensors is based upon impacts from the activation of the sensors.

Air Quality

Activation emissions from infrared and optical sensors would be similar to those discussed for radars. These impacts would be the same in all of the biomes considered in this PEIS.

Airspace

No impacts to airspace would be expected due to the activation infrared and optical sensors.

Biological Resources

No impacts to biological resources would be expected due to the activation infrared and optical sensors.

Geology and Soils

Impacts to geology and soils from activation of infrared and optical sensors would be similar to those discussed for radars. Infrared and optical sensor activation activities would produce the same impacts on geology and soils in all of the biomes considered in this PEIS.

Hazardous Materials and Hazardous Waste

Impacts to hazardous materials and hazardous waste from activation of infrared and optical sensors would be similar to those described for radars.

Health and Safety

Safety exclusion zones would be established around generator wiring and cabling to protect personnel from high voltage exposure. These impacts would be the same in all of the biomes considered in this PEIS.

Noise

Noise impacts associated with activation of infrared and optical sensors would be similar to those described for radars. These impacts would be the same in all of the biomes considered in this PEIS.

Transportation

There would be no impacts to transportation from the activation of infrared and optical sensors.

Water Resources

Impacts to water resources from activation activities would be similar to those described for radars. These impacts would be the same in all of the biomes considered in this PEIS.

Orbital Debris

Impacts from orbital debris related to space-based sensor activities would be similar to those described for radars. See Section 4.1.1.3.

4.1.1.5 Sensors - Laser Sensors

As described in Exhibit 4-3, the analysis for laser sensors is based upon impacts from the activation of the sensor.

Air Quality

Laser sensor activation activities would produce the same air quality impacts in all of the biomes considered in this PEIS. Laser sensors include gas lasers and solid-state lasers that expend low-level infrared radiation to form a focused laser beam. (MDA, 2003a) Potential emissions produced during activation would depend on chemicals used. These emissions would typically be released to the air where the impacts would be as discussed below.

The operation of a CO_2 gas laser sensor, like the Active Ranging System (ARS) laser associated with the ABL, would include the use of helium, N_2, and CO_2. (MDA, 2003a) None of these inert gases are considered hazardous; however, they can be asphyxiants, replacing oxygen to create oxygen-deficient conditions. A leak of these gases to the atmosphere would be insignificant relative to ambient oxygen concentrations. Impacts from asphyxiants would occur only in confined areas. Gas laser sensors could use a glycol (Refrigerant 404) closed-loop cooling system. Refrigerant 404 is an ozone-depleting substance; however, the closed-loop system would prevent releases to the atmosphere. In the unlikely event that a release does occur during testing or activation, the small amount released would quickly be dispersed and would not significantly impact air quality.

Solid-state lasers like the Beacon Illuminator Laser (BILL) and the TILL associated with the ABL have crystals as the active medium. Operation of these lasers causes thermal expansion of the crystal, which alters the effective cavity dimensions, thus changing the mode structure of the laser. The lasers are cooled by non-hazardous liquids such as water and deuterium oxide, which are in closed looped systems. No pollutant emissions are associated with the testing and activation of these lasers, therefore no impacts to air quality would be expected.

Airspace

The use of laser sensors would occur in cleared airspace within designated airspace areas. Close coordination with the FAA ARTCC and relevant military installations with responsibility for airspace management would minimize the potential for any adverse impact on airspace use. Lasing activities would be suspended immediately when ground observers using binoculars indicate an aircraft might be approaching the area; therefore, no impacts to airspace would be expected. Laser sensor activation activities from the

ground would produce the same airspace impacts in all of the biomes considered in this PEIS.

Flight-testing and activation activities for air-based laser sensors would occur at altitudes greater than 10,671 meters (35,000 feet) above MSL. Targets would be actively engaged at or above 10,671 meters (35,000 feet) above MSL, and would not engage below the 10,671 meters (35,000 feet) horizon. This would ensure activation of the laser sensors at an upward angle from the 10,671 meters (35,000 feet) horizon, and thus above commercial aircraft traffic and away from the Earth's surface. Due to the negative impacts of cloud cover on sensing lasers and the increase in air traffic below the 10,671 meters (35,000 feet) horizon, activation of lasers in a deployed situation would be conducted above the 10,671 meters (35,000 feet) horizon as well.

Activation of lasers would occur in cleared airspace within designated airspace use. Close coordination with the FAA ARTCC and relevant military installations with responsibility for airspace management would minimize the potential for any adverse impacts on airspace use.

Biological Resources

Impacts to biological resources as a result of activation of laser sensors could occur. Ground testing of air-based lasers has the greatest potential for impacts. Wildlife in the beam path of the laser could suffer eye damage as a result of the laser activation. Due to the short duration of the laser operations during testing and the small range area used for the ground testing, impacts to wildlife would be insignificant. Laser sensor activation activities would produce the same biological resource impacts in all of the biomes considered in this PEIS.

Flight-testing and activation of air-based laser sensors would occur at an altitude of 10,671 meters (35,000 feet) above MSL or greater. Impacts from the laser operation on biological resources on the ground would be insignificant. Birds in the beam path of the laser could suffer eye damage as a result of the laser activation. However, bird densities at 10,671 meters (35,000 feet) above MSL would be extremely low, and the time of exposure to the beam path would be extremely low as well. Also, because the laser beams from solid-state laser sensors are usually not continuous, but consist of a large number of separated or pulsed power bursts, it is highly unlikely that a bird would remain within a beam for any considerable length of time. Therefore, significant impacts to birds would not be expected. (MDA, 2003a)

Impacts from the activation of land-, and sea-based lasers would be insignificant. The beam path of land-, and sea-based lasers would be directed at an upward angle from the Earth's surface, and thus would not impact biological resources on the ground. Impacts

to birds and from beam reflection would be similar to those described for air-based laser sensors.

Impacts to biological resources as a result of testing and activation of space-based laser sensors would be insignificant. In the unlikely event that the laser was directed towards the Earth's surface, distortion from atmospheric conditions would reduce the radiance level of the lasers. The ANSI refers to the eye hazard distance as the Nominal Ocular Hazard Distance. This distance is defined as "the distance along the (propagation) axis of the unobstructed beam from a laser … to the human eye beyond which the … exposure … is not expected to exceed the appropriate MPE." (MDA, 2003a)

The Earth's surface would likely be beyond the Nominal Ocular Hazard Distance of the laser sensor, and thus, the impacts would be insignificant.

Geology and Soils

No impacts to geology and soils would occur as a result of activation of land-, sea-, air-, and space-based laser sensors. The only hazardous material that would be used to cool gas laser sensors is a gas at ambient conditions and would not impact geology and soils.

Hazardous Materials and Hazardous Waste

Laser sensor activation activities would produce the same hazardous materials and hazardous waste impacts in all of the biomes considered in this PEIS. The types of hazardous materials used and waste generated would be similar to those currently used and generated at military installations. No hazardous materials would be used during activation of lasers. Gas laser sensors would use CO_2, helium and N_2 to generate the laser, but these substances are not hazardous. These gases would be held in compressed gas tanks and would be handled according to all applicable Federal, state, and local regulations. Gas laser sensors would use a glycol (Refrigerant 404) cooling system. (MDA, 2003a) Refrigerant 404 is an ozone-depleting substance. However, the cooling system would be a closed loop system, and the refrigerant would be replaced only during routine maintenance. Used refrigerant would be handled and disposed of or recycled according to all applicable Federal, state, and local regulations. Accidental releases of hazardous materials would be contained in accordance with a site-specific spill plan.

Solid-state laser sensors would use non-hazardous crystals as the laser generating medium. These sensors could use either water or deuterium in their cooling systems. (MDA, 2003a) These non-hazardous coolants would be contained in closed-loop systems and would be recycled or replaced as needed.

Health and Safety

Laser sensor activation activities would produce the same impacts on health and safety in all of the biomes considered in this PEIS. Laser sensors are created by chemical reactions that release low levels of energy in a focused energy beam that is invisible to the naked eye. Despite its relatively low energy level, the laser beams can be hazardous to the eyes of living organisms within a certain proximity (or hazard distance) specific to the parameters of the laser beam. The MPE of the laser's energy is the standard that indicates "the level of laser radiation to which a person may be exposed without hazardous effect or adverse biological change in the eye." (ANSI Z136.1, *Safe Use of Lasers*, as referenced in MDA, 2003a) The MPE is a function of laser wavelength and exposure duration, but also varies based on waveform (pulsed or chopped), and the waveform's respective parameters (e.g., for pulsed waves, pulse width and pulse repetition frequency are additional factors in the MPE calculation).

The MPE and output parameters, such as power and divergence or beam spread, can be used to evaluate the hazard at various proximities, known as the eye hazard distances. ANSI refers to the eye hazard distance as the Nominal Ocular Hazard Distance. This distance is defined as "the distance along the (propagation) axis of the unobstructed beam from a laser … to the human eye beyond which the … exposure … is not expected to exceed the appropriate MPE."

Laser light is predominantly scattered forwards and backwards, whereas relatively little is scattered sideways. Therefore, an organism would have to look straight down the beam to be at risk. Some laser beams, such as those produced by gas laser sensors, diverge once they leave the sensor, therefore a lower hazard risk would be expected as the distance between the source sensor and a receptor increases. Other laser beams, like those produced by solid-state laser sensors, may maintain or increase their focus once they leave the sensor. When the laser's focus is maintained instead of diverging, the laser may become hazardous to an organism's eyes at a certain distance (e.g., two kilometers) before the primary focus point and stay hazardous until that same distance (e.g., two kilometers) after the primary focus point. (MDA, 2003a)

The DoD follows limitations outlined in ANSI Z136.1, *Safe Use of Lasers*, for the testing and activation of laser sensors. The limitations include establishing a restricted area excluding all but authorized and properly trained personnel, displaying warning signs designating the restricted area, removing reflective surfaces, and incorporating automatic hard-stop limits and/or laser blanking devices. This last measure would ensure that laser energy does not extend beyond natural features or backstops during testing scenarios. (MDA, 2003a) Safety exclusion zones would be established around generator wiring and cabling to protect personnel from high voltage exposure.

Noise

Noise impacts associated with activation of laser sensors would be similar to those discussed for radars. These impacts would be the same in all of the biomes considered in this PEIS.

Transportation

Testing and activation of land-, sea-, air-, and space-based lasers could impact the use of airspace. These impacts are discussed in the Airspace section. These impacts would be the same in all of the biomes considered in this PEIS.

Water Resources

Laser sensor activation activities would produce the same impacts on water resources in all of the biomes considered in this PEIS. Gases used to generate gas laser sensors are inert and would not impact water resources through atmospheric deposition. Refrigerant 404 would be used to cool gas laser sensors in a closed loop system. In the unlikely event of a spill or leak, the coolant becomes a gas under ambient conditions and would not impact water resources.

Solid-state laser sensors would use either water or deuterium oxide as a coolant. Deuterium oxide is water that contains a significantly higher proportion of deuterium atoms to ordinary hydrogen atoms. The laser coolants would operate within a closed-loop system and are only replaced during general maintenance requirements. The cooling liquids are non-hazardous and would not be expected to impact water resources.

Orbital Debris

Impacts from orbital debris related to space-based laser sensor activation activities would be similar to those described for radars. See Section 4.1.1.3.

4.1.1.6 C2BMC - Computer Terminals and Antennas

As described in Exhibit 4-3, the analysis for computer terminals and antennas is based upon impacts from the activation of the computer terminals and antennas. Impacts from site preparation and construction activities related to computer terminals and antennas are addressed in Support Assets.

Air Quality

Activation emissions from computer terminals and antennas would be limited to exhaust produced by generators. Impacts related to generator emissions are discussed in Support Assets. These impacts would be the same in all of the biomes considered in this PEIS.

Airspace

Activation activities for computer terminals and antennas would have the potential to impact airspace use by utilizing radio transmission frequencies, which may interfere with commercial air traffic control communications. The magnitude of the impact on airspace would depend on the specific location proposed. In accordance with standing regulations, MDA would coordinate radio frequency use and testing with the appropriate air traffic control agencies. A re-radiation tower is a transmission and receiving tower used in conjunction with fiber optic cable to verify the communication link between radar and an interceptor missile. Re-radiation towers can be built to heights of 31 meters (100 feet) and could impact airspace as collision hazards if constructed adjacent to airports and airfields. MDA would coordinate tower siting with the appropriate air traffic control agencies to avoid conflicts with established takeoff and landing patterns.

Biological Resources

Activation activities for land-, sea, and air-based computer terminals and antennas would have the potential to impact biological resources. The level of impact would vary based on the frequency and energy of the signal, and the proximity of the source to sensitive environments or specific threatened or endangered species, as well as the specific location proposed. In accordance with standing regulations, MDA would coordinate radio frequency use and testing with the appropriate resource management agencies.

Re-radiation towers are built to heights of up to 31 meters (100 feet). There is a potential risk of bird collisions with these towers. MDA could mitigate this risk by using highly visible paints and warning lights on the towers.

Space-based computer terminals and antennas would be in GEO and would have no impacts on biological resources.

Geology and Soils

Impacts to geology and soils from computer terminals and antennas would be limited to site preparation and construction activities. These activities are discussed in Support Assets. No impacts to geology and soils are anticipated as a result of the activation of computer terminals and antennas in any biome considered for this PEIS. (U.S. Army Space and Missile Defense Command, 2002d)

Hazardous Materials and Hazardous Waste

Regular maintenance and operation activities at land-based computer terminal and antenna sites would involve a continuous but relatively low level of hazardous materials use. These activities would produce the same hazardous materials and hazardous waste in all of the biomes considered in this PEIS. The anticipated amounts of hazardous materials used at the site are not known but are expected to be small. They could include protective coatings, lubricants and oils, motor and generator fuels, cleaning agents (isopropyl alcohol), backup power batteries, adhesives, and sealants. (U.S. Army Space and Missile Defense Command, 2002d) The use and disposal of these materials would be incorporated into hazardous material and waste management documents, such as an SWPPP and an Oil and Hazardous Substance Discharge Prevention and Contingency Plan. (U.S. Army Space and Missile Defense Command, 2002d) The hazardous materials would be stored in a centralized location for distribution when needed for maintenance. Material Safety Data Sheets would be posted at all locations where hazardous materials are stored or used. A site-specific hazardous materials management plan and an SPCC plan would be developed for the sites. (U.S. Army Space and Missile Defense Command, 2002d) The use and storage of hazardous materials would be in accordance with these regulations and applicable Federal, state, and local regulations. A Pollution Prevention Plan would be implemented for the proposed sites. This plan would control and reduce the use of hazardous materials at the installation site. (U.S. Army Space and Missile Defense Command, 2002d) In addition, the program would comply with any existing base Pollution Prevention Plan. Program personnel would continue to update the system-wide Pollution Prevention Plan, which would outline strategies to minimize the use of hazardous materials over the life cycle of the facilities.

Any hazardous waste generated from the use of these materials would be handled in accordance with appropriate Federal, state, and local regulations. Site-specific hazardous waste management plans would be in place for the operation and maintenance of the sites. If a release were to occur, all hazardous waste would be handled in accordance with appropriate regulations. In addition, a trained spill containment team would manage any release of hazardous waste at the site. (U.S. Army Space and Missile Defense Command, 2002d)

Health and Safety

Activation activities for computer terminals and antennas would have the potential to impact the health and safety of MDA personnel and the general public through the use of radio transmission frequencies and hazardous materials. These activities would produce impacts in all of the biomes considered in this PEIS; however, the impact would vary based on the site selected. The level of impact would vary based on the frequency and energy of the signal, the amount of hazardous materials to be used, and the proximity of the source to MDA personnel or the general public. MDA would train operating

personnel in the operation and maintenance of C2BMC equipment, and would not direct or use C2BMC equipment in a manner that would adversely impact the health and safety of the general public.

Noise

Computer terminal and antenna activation would produce the same type of noise in all biomes considered in this PEIS. Noise impacts associated with activation of computer terminals and antennas would be limited to noise produced by generators. Impacts related to generator noise are discussed in Support Assets.

Transportation

Impacts to transportation due to activation of computer terminals and antennas would be minimal in all biomes considered for this PEIS. Personnel operating and maintaining the components would generate the only traffic as a result of the activation. Personnel would be on site only during operational hours and during routine maintenance activities. (U.S. Army Space and Missile Defense Command, 2003) Impacts as a result of activation would be insignificant.

Water Resources

Additional personnel would be needed for the activation of computer terminals and antennas; these personnel would increase the demand for potable water. Potable water demands associated with the activation activities would be relatively minimal. However, an increase in demand could exceed the capacity of the existing infrastructure. (U.S. Army Space and Missile Defense Command, 2003) This is of particular concern in portions of the Sub-Arctic Taiga, Grasslands, Desert, Tropical, Mountain, and Savanna Biomes where access potable water may be limited. Additional packaged potable water systems could be installed to meet the demands. Site-specific studies should consider the limited potable water supplies in these areas when analyzing the impacts to water resources from the proposed activities. In other biomes including Arctic Tundra, Sub-Arctic Taiga, Deciduous Forest, and Chaparral Biomes, water resources are generally not scarce and therefore, it is unlikely that water demand from additional personnel associated with activation of computer terminals and antennas would exceed the existing capacity. However, there may be site-specific or localized water resource availability issues and these should be considered for any biome.

Operation of the components would have negligible effects on water quality. Implementation of a SWPPP and best management practices would reduce the risk of impacts from erosion and sedimentation to nearby surface waters. Compliance with the SPCC Plan would minimize the potential for accidental spills of hazardous materials and hazardous wastes to affect surface and ground water resources.

Space-based computer terminals would be in GEO and would have no impacts on water resources.

Orbital Debris

Space-based computer equipment could reenter the Earth's atmosphere due to failure, but would not likely result in significant impacts. Impacts from orbital debris related to space-based computer terminal and antenna activation activities would be similar to those described for radars. See Section 4.1.1.3.

4.1.1.7 C2BMC - Underground Cable

As described in Exhibit 4-3, the analysis for underground cable is based upon impacts from the activation of the underground cable.

Air Quality

Air quality impacts associated with underground cable would be limited to ground disturbances resulting from construction activities. These impacts are discussed in Support Assets. Activation activities related to underground cable would not have any impact on air quality in any biome considered for this PEIS.

Airspace

The activation of underground cable would not have any impact on airspace in any biome considered for this PEIS.

Biological Resources

Impacts to biological resources may occur during site preparation, these impacts are discussed in Support Assets. Activation of underground cable would not result in any impacts to biological resources in any biome considered in this PEIS.

Geology and Soils

Impacts to geology and soils would be limited to site preparation activities. Activation of underground cable would not result in any impacts to geology and soils in any biome considered in this PEIS.

Hazardous Materials and Hazardous Waste

Impacts from hazardous materials and hazardous wastes would be limited to site preparation activities. No hazardous materials or wastes would be generated from the

activation of terrestrial and marine underground cable. Therefore, no significant impacts from hazardous materials or hazardous waste would be expected in any biome considered in this PEIS.

Health and Safety

Potential health and safety hazards from site preparation include dust/particulate inhalation, improper chemical handling, and improper use of machinery; these impacts are discussed in Support Assets. No impacts to health and safety would be expected from activation-related activities in any biome considered in this PEIS.

Noise

The activation of underground cable would not produce noise that has the potential to impact sensitive receptors.

Transportation

There would be no significant impact to transportation from activation underground cable in any biome considered in this PEIS. Any necessary repairs to underground cable would require excavation of the cable. These maintenance activities could result in impacts to transportation through movement of equipment and personnel to the repair site. However, repair events would occur infrequently and would require much less activity than that needed for construction. Therefore, impacts to transportation would be insignificant.

Water Resources

Potable water demand for the installation and activation of underground cable would be small. Impacts from the demand for potable water associated with an increase in the number of project related personnel would be as described for Water Resources for Computer Terminals and Antennas. Impacts to water resources may occur during site preparation, particularly in marine environments. These impacts are discussed in Support Assets.

Orbital Debris

The use of underground cable would have no impact on orbital debris.

4.1.1.8 Support Assets - Equipment

Support equipment includes transportation and portable equipment (e.g., automotive, ships, aircraft, rail, generators, cooling units, storage tanks, chemical transfer equipment,

aerospace ground equipment), BMDS Test Bed support equipment (e.g., aircraft, vehicles, ships, mobile launch platforms, operator control units, sensor operations equipment [antenna, electronic equipment, cooling equipment, prime power units]), and weapons basing platform equipment (e.g., Heavy Expanded Mobility Tactical Truck with Load Handling System, Aegis Cruiser, ABL aircraft), as discussed in Section 2.2.4.1 and Section 4.0. This equipment is part of the military services inventory and is used to support mission-related activities.

MDA reviewed the impact analyses and conclusions in previously prepared site-specific NEPA documentation, specifically for the use of transportation of equipment and use of general portable equipment. The use of this type of support equipment has been analyzed in a number of previously prepared documents, including the *Ballistic Missile Defense Programmatic Environmental Impact Statement* (BMDO, 1994); *Ground-Based Midcourse Defense Initial Defense Operations Capability at Vandenberg Air Force Base Environmental Assessment* (MDA, 2003b); *Ground-Based Midcourse Defense Extended Test Range Environmental Impact Statement* (U.S. Army Space and Missile Defense Command, 2003); *National Missile Defense Deployment Environmental Impact Statement* (U.S. Army Space and Missile Defense Command, 2000); *Theater Missile Defense Extended Test Range Supplemental Environmental Impact Statement* (U.S. Army Space and Strategic Defense Command, 1998a); *Theater Missile Defense Extended Test Range Environmental Impact Statement* (U.S. Army Space and Strategic Defense Command, 1994a): *Evolved Expendable Launch Vehicle Program Environmental Impact Statement* (U.S. Department of the Air Force, 1998); *Point Mugu Environmental Impact Statement/Overseas Environmental Impact Statement* (U.S. Department of the Navy, 2002b); and *Pacific Missile Range Facility Enhanced Capability Environmental Impact Statement* (U.S. Department of the Navy, 1998). The use of general portable equipment and transport of equipment as defined in the previously prepared NEPA documents would not result in a significant impact.

For example, analyses on generator and transportation emissions conducted at KLC showed that emissions associated with the use of the facility and associated equipment for missile defense activities would be below the 90.7-metric-ton (100-ton) per year criteria pollutant Federal *de minimis* levels that apply to a non-attainment area. However, the use of certain generators would require an amendment to the existing Pre-approved Limit Permit for KLC. (U.S. Army Space and Missile Defense Command, 2003)

In addition, at Vandenberg AFB, procedures are in place so target missile launches would not represent a significant new impact on transportation, including air traffic, vehicular traffic, rail traffic, and marine traffic. (U.S. Army Space and Strategic Defense Command, 1994) Other transportation analyses found that the use of aircraft and commercial ground transportation vehicles to ship equipment from various manufacturing locations to basing locations would result in minor air emissions that were determined to be less than significant.

In many instances, transportation activities can be categorically excluded from further NEPA analysis. In accordance with DoD regulations for implementing NEPA (32 CFR 188), CEQ regulations provide for the establishment of categorical exclusions (40 CFR 1507.3(b)) for those actions, which do not individually or cumulatively have a significant impact on the human environment. Where appropriate, DoD has established such categorical exclusions. For example, infrequent, temporary (less than 30 days) increases in air operations up to 50 percent of the typical installation aircraft operation rate, are categorically excluded.

Review of previously prepared NEPA analyses and existing categorical exclusions have indicated that impacts associated with transportation would not be significant. Transportation activities would be performed in accordance with existing operating procedures and appropriate regulations, as well as in accordance with appropriate NEPA analyses. The shipment or transportation of hazardous and non-hazardous materials would be performed in accordance with applicable DOT standards, as well as established handling and transfer procedures. Proper containment, handling procedures, separation of reactive chemicals, and worker warning and protection systems would be used where necessary. Site-specific spill prevention guidelines, including leak detection and spill control measures, would be followed. However, if the proposed BMDS would increase transportation activities or result in the use of mobile support assets over existing levels or over what has been determined to be categorically excluded, site-specific NEPA analyses might be required.

As discussed above, general portable equipment has been considered in previously prepared NEPA analyses. These analyses demonstrate that the impacts associated with their use would not be significant. The use of some specific element support equipment has also been previously analyzed, and the impacts associated with their use would not be significant.

The use and operation of support equipment would be in accordance with installation-specific requirements that consider impacts on local, regional, and global environmental resources. The ongoing activities that occur at specific installations would be performed in accordance with appropriate Federal, state, and local regulations, and therefore would not be expected to result in a significant impact. Potential operational limitations include restrictions on timing, duration, or operational requirements as dictated through consultations and memorandums of agreement with appropriate regulatory agencies.

The following sections present the impacts associated with operational changes including implementation of new operating parameters for existing support equipment. These operational changes have not been previously analyzed or categorically excluded.

Air Quality

An increase in use of support equipment that results in increased emissions of a criteria pollutant, of a HAP, or of pollutants that affect regional haze could impact air quality. The significance of such impacts on air quality depends on the local or regional regulatory setting as well as the physical climate conditions where the emissions would occur. The regulatory setting includes EPA recognized non-attainment and maintenance areas, areas that have submitted regional haze SIPs to EPA, and locations that have sensitive receptors to HAP emissions. Each of the regulated areas occurs throughout the U.S. and its territories, which include all of the biomes except for the BOA and the Atmosphere.

The physical climate conditions that would affect the intensity and severity of the impact include regions that have periods of air inversions or other climatic conditions that does not permit normal air circulation or turnover to occur. Such conditions occur in the Chaparral, Mountain, and Tropical Biomes.

For areas that fall under a regulated setting through non-attainment and maintenance area designations, regional haze requirements, and their associated SIPs, the regulatory constraints of the location would be addressed in an action specific analysis. The impacts related to the emissions of HAPs would depend on the proximity of sensitive receptors in the impacted area. This type of analysis would require dispersion modeling or other risk calculation methods to evaluate the degree of the impact and identify appropriate mitigation measures.

If emissions are produced that are greater than the *de minimis* values, or if the emission increase would equal or exceed ten percent of the total emission inventory for the entire non-attainment area, then, a Conformity Determination under the Clean Air Act would be required. The *de minimis* thresholds in non-attainment areas are presented in Section 3 in Exhibit 3-3. A review of the state specific SIPs would be performed to identify whether the actions would equal or exceed 10 percent of the total emission inventory.

Airspace

The implementation of new operating parameters for existing support equipment would not impact airspace in any of the biomes considered. An increase in operations of support assets could affect the airspace of the biome where such activities would occur. The impacts on the airspace in the various biomes would be insignificant because all operations involving support equipment would be performed in accordance with existing airspace use requirements.

Biological Resources

Operational use changes could impact biological resources in the various biomes where such activities would occur. The impacts on biological resources would result from emissions of criteria pollutants and HAPs, equipment emitting EMR or radio frequencies, operations within sensitive environments (wetlands, critical habitat, essential fish habitat, wild and scenic rivers, or other protected natural resource areas), and debris from missile intercepts, catastrophic failure, or flight terminations. Methods employed to reduce impacts on natural resources including scheduling and duration considerations, as well as informal and formal consultations with regulatory agencies would be expected to reduce the potential for impact below significant levels. Should the impacts affect a threatened or an endangered species or its habitat, essential fish habitat, jurisdictional wetlands, or another regulated resource then in addition to analysis under NEPA and other applicable laws (Clean Water Act, Endangered Species Act), regulatory agency consultation would be required. The appropriate Federal agency must be consulted under Section 7 of the Endangered Species Act when site specific analysis indicates the continued existence of a threatened or endangered species is likely to be jeopardized.

Geology and Soils

In most biomes an operational use change would not impact geology or soils. However, in the Artic Tundra and Sub-Arctic Taiga Biomes, construction or modification activities have the potential to alter the condition of the permafrost that covers the biome. In addition, these biomes may be subject to earthquakes.

When appropriate, construction would incorporate seismic design parameters consistent with the critical nature of the facility and its geologic setting. In biomes with floodplains and the coastal environments, siting of facilities should consider the proximity to 100-year floodplains and maximum probable tsunami wave run-up areas.

Hazardous Materials and Hazardous Waste

An operational use change could result in an impact from the use of hazardous materials and the generation of hazardous waste, if such materials were used in the process. Such impacts could affect the biome where the action would occur. Should an operational use change result in new hazardous materials or hazardous waste, such items would be handled in accordance with specific protocols and appropriate regulations. Federal military ranges have established procedures in accordance with Federal regulations to ensure proper handling and use of these hazardous materials. These procedures would be reviewed to ensure that they address the hazardous materials that would be used. An evaluation of the potential impacts would occur if operational changes would utilize hazardous materials or generate hazardous waste not addressed in relevant specific protocols. All hazardous waste generated would be disposed of in accordance with

applicable laws and regulations. The personnel involved in hazardous material operations would be trained in the appropriate procedures, use appropriate personal protective clothing, and be up-to-date on any specialized training in hazardous material handling, spill containment and cleanup, or other hazardous material activities

Health and Safety

An operational use change would have the potential to impact health and safety. Impacts on health and safety are not associated with particular biomes; rather they are associated with the processes and activities that would be implemented under a specific action. The personnel who would operate equipment would be familiar with standard operating procedures and would receive specific equipment training as necessary. In addition to adhering to existing procedures, all activities would be performed in accordance with the health and safety requirements of the specific installation or test range, which are designed to protect public heath and safety.

Noise

Operational changes could impact ambient noise levels. Such impacts would affect the biome where the action would occur, and include new sources of noise or new operations that would alter the intensity, frequency, or duration of a noise-emitting source. The severity of such an impact would be related to the proximity of sensitive receptors to the noise source. Receptors include DoD workers, the general pubic, noise sensitive areas (housing developments, schools), and wildlife including critical habitat. An action- or site-specific study, in accordance with NEPA, would be performed for activities that may impact noise. Such a study would identify the receptors, quantify the impact, and recommend mitigation measures.

Transportation

Operational use changes could result in impacts to transportation; however, these impacts would not be significant. Mobile equipment would be used for a limited time during a test event, or would be used to transport supplies and components to and from various facilities. As indicated in Section 4.1.1.2, the use of support equipment during launch and post-launch activities (debris recovery) would not be expected to significantly impact transportation.

Water Resources

Because operational use changes of existing infrastructure would occur at existing facilities specifically designed for the support equipment in accordance with all relevant and applicable regulations, such activities would not impact water resources in any of the biomes. Operational use changes that would result in impacts to areas not specifically

designed for use of the support equipment could be subject to additional environmental review.

Orbital Debris

No impacts from orbital debris would occur as a result of an operational use change of support equipment.

Space-based equipment (satellites) could reenter the Earth's atmosphere due to failure, but would not likely result in significant impacts. Most objects break up and often vaporize under the intense aerodynamic forces and heating that occur during reentry. Most of the objects which reenter would fragment and burn in the upper atmosphere and would make only negligible changes in its chemical composition. Even if an object does survive reentry, only one third of the Earth is land area, and only a small portion of this land area is densely populated. The chance of hitting a populated land area upon reentry would be small. (SDIO, 1992)

4.1.1.9 Support Assets - Infrastructure

The following discussion of support asset infrastructure includes BMDS Test Bed infrastructure (test ranges and associated facilities), non-BMDS Test Bed Infrastructure (radar and tracking stations), and weapons basing platform infrastructure (missile silos) as discussed in Section 2.2.4.1 and Section 4.0. This equipment is part of the military services inventory and is used to support mission-related activities.

MDA reviewed the impact analyses and conclusions in previously prepared site-specific NEPA documentation, specifically for the use and modification of existing infrastructure, repair, maintenance, and sustainment. These activities have been analyzed in a number of previously prepared documents, including the *Ballistic Missile Defense Programmatic Environmental Impact Statement* (BMDO, 1994); *Ground-Based Midcourse Defense Initial Defense Operations Capability at Vandenberg Air Force Base Environmental Assessment* (MDA, 2003b); *Ground-Based Midcourse Defense Extended Test Range Environmental Impact Statement* (U.S. Army Space and Missile Defense Command, 2003); *National Missile Defense Deployment Environmental Impact Statement* (U.S. Army Space and Missile Defense Command, 2000); *Theater Missile Defense Extended Test Range Supplemental Environmental Impact Statement* (U.S. Army Space and Strategic Defense Command, 1998a); *Theater Missile Defense Extended Test Range Environmental Impact Statement* (U.S. Army Space and Strategic Defense Command, 1994a): *Evolved Expendable Launch Vehicle Program Environmental Impact Statement* (U.S. Department of the Air Force, 1998); *Point Mugu Environmental Impact Statement/Overseas Environmental Impact Statement* (U.S. Department of the Navy, 2002b); and *Pacific Missile Range Facility Enhanced Capability Environmental Impact*

Statement (U.S. Department of the Navy, 1998), and *Mobile Sensors Environmental Assessment (MDA, 2005).*

These previous analyses show that potential impacts from infrastructure modification include construction-related impacts that could result from PM and construction equipment emissions. These emissions would be short-term, and would only affect those receptors close to construction areas. Activities that would continue in existing facilities at government and contractor installations would not result in any significant impacts. All activities would follow applicable regulations and established guidelines and management practices. Any increased water demands or demands on other utilities (electricity, natural gas, waste water disposal) that could be readily met by existing supply and treatment systems, groundwater withdrawals, or alternative sources, would not result in significant environmental impacts. (BMDO, 1994)

In many instances, use and modification or maintenance and sustainment of existing infrastructure is categorically excluded from further NEPA analysis. For example, per 32 CFR Part 651, Appendix B, construction of an addition to an existing structure or new construction on a previously undisturbed site is categorically excluded if the area to be disturbed has no more than five cumulative acres of new surface disturbance, and the construction does not individually or cumulatively have a significant effect on the human environment.

Previous analyses show that the impacts of such activities in support of the BMDS would not be significant because such activities would be performed in accordance with existing regulations. However, if proposed BMDS activities would result in major modification of existing infrastructure or major changes in use, site-specific NEPA analysis would be required. Additionally, changes in the level of human services used to support BMDS activities would be analyzed in site-specific NEPA analysis. In accordance with 40 CFR Part 1508.14, the site-specific NEPA analysis would address the socioeconomic impacts that are interrelated with impacts on the natural and physical environment.

The following sections present the impacts associated with site preparation and construction, including the modification of existing infrastructure, which are not sufficiently covered in previous NEPA analyses or categorically excluded.

Air Quality

The development of new or the major modification of existing infrastructure could impact air quality. Such impacts would affect the biome where the action would occur, and would result from site preparation and construction activities. Estimates of air quality impacts from construction are based on building square footage, acreage disturbed, and duration of construction, as well as general meteorological and soil information. Construction would require ground disturbances resulting in PM_{10} and

fugitive dust impacts. In 1995, EPA estimated that ground-disturbing activities cause the release of 1.08 metric tons (1.2 tons) of uncontrolled fugitive dust emissions per 0.4 hectare (1 acre) per month of ground-disturbing activity. (U.S. Army Space and Missile Defense Command, 2003) An estimated 50 percent of fugitive dust emissions consist of PM_{10}, though a more accurate percentage is based on the makeup of the local soil. (U.S. Army Space and Missile Defense Command, 2003) Standard fugitive dust reduction measures would be implemented when necessary. Water trucks might be used to dampen soil to minimize dust by releasing water or another biodegradable dust suppressant. The speed of construction vehicles would be restricted to limit soil separation into dust, and any soil stockpiled as fill material would be covered until use to prevent moisture evaporation and separation induced by wind. (MDA, 2003b)

The use of construction equipment would result in emissions of CO, NO_X, VOCs, and oxides of sulfur. Potential construction equipment emissions would be determined on a site-by-site basis by using emission factors from various sources including EPA. Proper tuning and preventive maintenance of construction vehicles would serve to minimize exhaust emissions and maximize vehicle performance. Construction would be conducted in accordance with all applicable laws and regulations. While the construction would cause an increase in air pollutants, it is assumed that the impact would be both temporary and localized. Once construction ceased, air quality would return to its former level.

Airspace

Site preparation and construction would not have any impact on airspace because all activities would take place on the ground and would not involve any closures or restrictions on airspace use. Modifications to infrastructure not previously addressed in NEPA analyses would not have any impact on airspace because the modifications would not result in any closures or restrictions on airspace use.

Biological Resources

Site preparation and construction could impact biological resources in the various biomes where such activities would occur. Vegetation, wildlife, and specific sensitive habitats could be affected based on the specific location of the development or modifications. The construction and expansion of buildings and roads could result in the clearing of vegetation and adverse impacts on wildlife near the activities. Site preparation activities may require pouring of pavement or spreading of gravel to facilitate mobility of the construction vehicles. Site preparation and construction activities that generate dust, irritable pollutants and noise, might temporarily disturb nearby wildlife, while permanent structures would result in the loss of habitat, displacement of wildlife, increased stress, and disruption of daily/seasonal behavior. (U.S. Army Space and Missile Defense Command, 2002d) Construction of infrastructure could lead to increased surface runoff. The combination of increased noise levels and human activity would likely displace some

small mammals and birds that forage, feed, nest, or have dens within a 15-meter (50-foot) radius of such activities. (U.S. Army Space and Missile Defense Command, 2002d) Whenever possible, construction and site preparation activities would occur on or near previously disturbed areas.

In Artic Tundra, Chaparral, and Tropical Biomes site preparation and installation activities for underground cable could impact species that rely on the shore environment including species of pinnipeds, shorebirds, waterbirds, otters and whales, and sea turtles. The installation of marine underground cable through near shore areas and through shoreline and tidal areas could disturb the habitats that these species depend on.

Pinnipeds and shorebirds are easily startled by noise and movement. (U.S. Army Space and Missile Defense Command, 2003) Site preparation and construction activities could cause a range of behavioral responses from heightened alertness to abandonment of favorable habitat areas. (U.S. Army Space and Missile Defense Command, 2003) It may also be possible for site preparation and construction noise to lead to nest abandonment or changes in migration routes. The severity of the response would depend on the intensity (noise level, area of the disturbance) of the installation project, the proximity to the pinniped and shorebird habitats, and the sensitivity of the species. Site-specific analyses would more accurately assess the potential impacts of the proposed activities on biological resources.

Shorebirds are very sensitive to noise during the nesting season. (U.S. Army Space and Strategic Defense Command, 1998a) The flushing of shorebirds from nests could result in the exposure of eggs to excess cold/heat and to predation.

Construction activities would be planned and sited to avoid regulated habitats (jurisdictional wetlands, critical habitat, or essential fish habitat). Should the impacts affect a threatened or an endangered species or its habitat, essential fish habitat, jurisdictional wetlands, or another regulated resource then in addition to analysis under NEPA, compliance with other laws (e.g., Clean Water Act, Endangered Species Act, Marine Mammal Protection Act, Migratory Bird Treaty Act, and Bald and Golden Eagle Protection Act), and regulatory agency consultation would be required. The appropriate Federal agency must be consulted under Section 7 of the Endangered Species Act when site specific analysis indicates the continued existence of a threatened or endangered species is likely to be jeopardized.

Environmentally sensitive habitats could be impacted by site preparation and construction activities for underground cable. Trenching through coral reef areas would adversely impact the reef. Coral reefs are slow developing habitats that are very sensitive to changes in water quality. The trenching activity would disturb seafloor sediment and would temporarily increase the turbidity of the water column. This would lower the solar light penetration that the reefs depend on for growth and energy. (University of the

Virgin Islands, 2003) In addition, the trenching activities would break up existing reef. Studies have shown that coral reefs are very sensitive to physical disturbances. Reefs that have been physically damaged can be more susceptible to disease. (University of the Virgin Islands, 2003) Underground cable site preparation and construction activities would comply with EO 13089 and would be avoided to the extent possible in coral reef areas.

The marine underground cable installation activities could startle and temporarily displace whales and sea otters. However, these species would likely return once the installation is complete. Installation activities that occur in freshwater and tidal streams could cause siltation and disturbance of maturation and feeding habitats for some species of fish. (U.S. Army Space and Strategic Defense Command, 1994a) Site-specific studies should analyze the potential impacts of the proposed activities on the biological resources of the affected environment.

Studies have shown that artificial light can affect sea turtle behavior. (U.S. Army Space and Strategic Defense Command, 1998a) Artificial light associated with construction sites could confuse nesting sea turtles causing abandonment of nesting sites. Artificial lights could also confuse hatchling turtles by causing them to move in circles and reducing their chances of making it safely to the ocean. (U.S. Army Space and Strategic Defense Command, 1998a) Trenching and backfilling in sea turtle nesting areas could disturb buried nests or cover the nests with a sand layer too deep for the hatchlings to escape. Because sea turtle and shorebird nesting is a seasonal process, construction activities could be coordinated to avoid nesting seasons. Site-specific analyses would more accurately assess the potential impacts of the proposed activities on biological resources.

Geology and Soils

Typical construction activities that could adversely affect local geology and soils include cut-and-fill operations, paving operations, compaction, mixing, grading, and general soil erosion. Exposed soils become dry and porous and shift easily resulting in increased erosion rates. Paving operations would degrade the quality of the soil as it mixes with tar and reduces permeable surfaces. Best Management Practices[53] would be implemented to minimize negative short-term effects of clearing and grading activities during site preparation, as well as excavations and grading for connecting infrastructure, roadways and parking. Any construction activities greater than five-acres would be required to obtain an NPDES storm water run-off permit, which typically specifies the Best Management Practices for the entire construction site. Except for localized soil compaction in the construction area, long-term impacts to the soils resulting from

[53] A best management practice is a business function, process, or system considered superior to all other known methods, that improves performance and efficiency in a specific area. (Office of the Secretary of Defense Comptroller iCenter, 2004)

construction would not be anticipated. (U.S. Army Space and Missile Defense Command, 2003)

Site preparation and construction could impact the geology and soils of the Artic Tundra and Sub-Arctic Taiga Biomes. Such impacts would be related to activities that alter the condition of the permafrost that covers the biome.

Whenever possible, construction and site preparation activities would occur on or near previously disturbed areas to limit or reduce disturbance of undisturbed areas. Construction would incorporate seismic design parameters consistent with the critical nature of the facility and its geologic setting. In biomes with floodplains and the coastal biomes, facilities should be constructed outside of existing 100-year floodplains and beyond established limits for tsunami wave run-up for a maximum probable tsunami event. (U.S. Army Space and Missile Defense Command, 2003)

Hazardous Materials and Hazardous Waste

Site preparation and construction and development could result in an impact from the use of hazardous materials and the generation of hazardous waste. Such impacts would affect the biome where the action would occur. Based on the type of infrastructure the potential hazardous wastes that would be generated during construction and site preparation include solvents, cutting fluids, acetylene, and various paint products, used acetone, motor fuels, heating fuels, waste oils, hydraulic fluids, used batteries, and waste antifreeze. Small quantities of solvents are typically used for degreasing or other cleaning activities. Residual solvents would be disposed of as hazardous waste along with contaminated materials (e.g., rags). Hazardous waste disposal would take place at permitted sites equipped to handle the safe and proper disposal of such materials.

A Pollution Prevention Plan would be implemented for new or major modification to existing infrastructure. This plan would control and reduce the use of hazardous materials at the site. (U.S. Army Space and Missile Defense Command, 2002d) In addition, the program would comply with any existing base Pollution Prevention Plan. Program personnel would continue to update the system-wide Pollution Prevention Plan, which would outline strategies to minimize the use of hazardous materials over the life cycle of the facilities.

Renovation and site preparation activities may generate wastes that include asbestos-containing material and lead-based paints. Prior to any existing building modification or demolition, surveys would be conducted to determine if these materials are present in the modification area. A licensed asbestos abatement contractor, in accordance with state and Federal regulations, would perform renovations in these instances. All removed asbestos would be disposed of in a solid-waste landfill designed to receive asbestos-containing material. Management and abatement of asbestos and lead-based paint at

selected sites would be compliant with management plans such as a Lead-Based Paint Management Plan, an Asbestos Management Plan, an Asbestos Operating Plan, as well as the applicable legal requirements. (U.S. Army Space and Missile Defense Command, 2003)

Health and Safety

Site preparation and construction could impact health and safety. Impacts on health and safety are not associated with particular biomes, rather are associated with the processes and activities that would be implemented under a specific action. Potential health and safety hazards from site preparation and construction activities include dust/particulate inhalation, improper chemical handling, and improper use of machinery. General safety procedures would be followed to protect construction workers, base personnel, and the general public during site preparation and construction activities. No impacts to human health and safety from site preparation and construction activities would be expected, if all applicable legal requirements are met.

Construction activities would produce physical hazards such as noise, electrical, heavy-moving equipment and machinery, welding, and earth moving and digging activities. Health and safety procedures would be compliant with appropriate management plans and applicable regulations. Any waste would be collected and segregated as non-hazardous, hazardous, and possibly special wastes for proper disposal in accordance with applicable legal requirements.

The design of new facilities or the modification of exiting facilities would incorporate measures to minimize the potential for and impact of health and safety related accidents. Operating procedures and training would be instituted to minimize the potential for and impact of releases of hazardous materials. Specific health and safety plans would be developed including evacuation plans, and notification of local and offsite emergency response as required.

Noise

Site preparation and construction and development of new or the major modification of existing infrastructure could impact ambient noise levels. Such impacts would affect the biome where the action would occur, and would be related to construction activities or new operations that would alter the intensity, frequency, or duration of a noise emitting source, and would depend upon the sensitivity of the receptor to the sound generated. Receptors include workers, wildlife, and the public in the proximity of the noise source. Site preparation and construction activities would be comparable to common construction activities. The amount of noise generated would depend upon the amount and type of construction being done. Construction on existing facilities would likely be minor; construction of new infrastructure could result in larger impacts. Personnel that may be

exposed to loud noises would be required to wear hearing protection, such as earplugs and earmuffs, which would reduce the noise levels to prescribed health and safety levels. An action or site-specific study would be performed for activities that may increase noise levels. Such a study would identify sensitive receptors and their locations, quantify the impact, and recommend mitigation measures.

Transportation

Site preparation and construction activities may require the use of heavy machinery the transportation of which could cause changes in the amount of congestion on the existing road network. In addition, an influx of construction workers may change the level of demand for access to the existing roadways. In general, these activities would not be expected to cause a significant impact on transportation. However, if these changes in demand and congestion demonstrate the potential for significant impact, site specific analyses would be prepared.

Water Resources

Site preparation and construction could impact water resources by increasing operations resulting in a discharge of wastewater. Modifications or construction activities would follow site-specific protocols for storm water and ground water pollution prevention, and would require application for appropriate permits and development of pollution prevention plans for protection of water resources on- and off-site. For new installations, site-specific documentation would be required to determine potential effects of construction and operation activities on surface water, ground water, and floodplains. The impacts on water resources would be analyzed in accordance with NEPA and other appropriate regulations, including the Clean Water Act and any applicable international or foreign legal requirements for activities outside of the U.S.

Orbital Debris

No impacts from orbital debris would occur as a result of site preparation and construction.

4.1.1.10 Support Assets - Test Assets

The following discussion of support asset test assets include assets of the BMDS Test Bed (test sensors and communications) and assets that are used to support the BMDS Test Bed (targets, countermeasures, and simulants) as discussed in Section 2.2.4.1 and Section 4.0. This equipment is part of the military services inventory and is used to support mission-related activities.

MDA reviewed the impact analyses and conclusions in previously prepared site-specific NEPA documentation, specifically for the development and use of test assets. These activities have been analyzed in a number of previously prepared documents, including the *Ballistic Missile Defense Programmatic Environmental Impact Statement* (BMDO, 1994); *Ground-Based Midcourse Defense Initial Defense Operations Capability at Vandenberg Air Force Base Environmental Assessment* (MDA, 2003b); *Ground-Based Midcourse Defense Extended Test Range Environmental Impact Statement* (U.S. Army Space and Missile Defense Command, 2003); *National Missile Defense Deployment Environmental Impact Statement* (U.S. Army Space and Missile Defense Command, 2000); *Theater Missile Defense Extended Test Range Supplemental Environmental Impact Statement* (U.S. Army Space and Strategic Defense Command, 1998a); *Theater Missile Defense Extended Test Range Environmental Impact Statement* (U.S. Army Space and Strategic Defense Command, 1994a): *Evolved Expendable Launch Vehicle Program Environmental Impact Statement* (U.S. Department of the Air Force, 1998); *Point Mugu Environmental Impact Statement/Overseas Environmental Impact Statement* (U.S. Department of the Navy, 2002b); and *Pacific Missile Range Facility Enhanced Capability Environmental Impact Statement* (U.S. Department of the Navy, 1998).

MDA also reviewed existing categorical exclusions to determine which activities associated with the development and use of test assets are categorically excluded from further NEPA analysis.

The activities previously analyzed and those that are categorically excluded include the development, manufacturing, and assembly of components and component prototypes at existing DoD and non-DoD (contractor) facilities.

For example, the *Theater High Altitude Area Defense Initial Development Program Environmental Assessment* (U.S. Army Space and Strategic Defense Command, 1994c) found that all manufacturing and engineering activities would be accomplished in existing facilities and would use personnel routinely engaged in these types of activities. The facilities and personnel utilized would operate at levels and intensities similar to current conditions, which would result in no significant impacts. In addition, the EA found that manufacturing and engineering various missile components would involve the use of various hazardous materials. Because the facilities would comply with the CCR, Title 22, Division 4, Environmental Health; Title 40 CFR, Parts 260-280, and the RCRA, as well as specific facility guidelines that describe procedures for items such as correct storage, labeling, and transportation of hazardous waste, such activities would be not significant.

Similarly, because the manufacturing and assembly of the BMDS components would occur at existing facilities, would follow established standard operating procedures to protect worker and public safety, and would be performed in accordance with all appropriate and relevant laws and regulations, the impacts associated with manufacturing

would not be significant. However, should an activity require new or major modification to an existing DoD-owned or operated manufacturing facility, or require the preparation of new assembly standard operating procedures, action-specific NEPA analysis would be conducted.

The use of test assets in various configurations has been considered in previous NEPA analyses. Most of this equipment is sensor, tracking (optical, laser, and radar systems), and communications systems. The use of such equipment is both installation- and scenario-specific. Previous analyses have shown that impacts associated with the use of support equipment for test assets would not be significant.

The use of targets and their boosters, target test objects, simulants and countermeasures at some specific locations has been considered in previous NEPA analyses. For example, the *Ground-Based Midcourse Defense Extended Test Range Environmental Impact Statement* (U.S. Army Space and Missile Defense Command, 2003), shows that the Peacekeeper target missile would contain less solid rocket fuel and would produce lower exhaust emissions that existing target missiles. In addition, modeling of target missiles to include dual launches demonstrated that the level of HCl emitted would be below the 1-hour Air Force standard, but would exceed the peak HCl standard for a short duration. The emission levels for both CO and Al_2O_3 were determined to be within NAAQS and California AAQS; therefore, the nominal launch of a single Peacekeeper target missile is anticipated to remain within NAAQS, California AAQS, and Air Force Standards. Previous analyses show that the impacts associated with the use of targets and their boosters for activities associated with the proposed BMDS would have no significant impacts.

The use of drones as targets has been considered in previous NEPA analyses and has not been found to result in significant impacts. Drones are used to mimic the heat and radar returns of missiles and aircraft, and can use various countermeasures to deceive interceptors. The potential for impacts from the use of drones is influenced by the specific flight pattern to be flown and intercept altitude, if appropriate. Site specific analysis including debris analysis might be required for future proposed actions using drones.

The development and use of individual test assets (e.g., sensors, targets, and drones) have been analyzed in site-specific NEPA documents, which found no significant impacts from such activities. The development and use of those test assets as defined in the previous site-specific NEPA documents would not result in a significant impact. The combined impact associated with test assets and the other BMDS components was analyzed in Section 4.1.2, Test Integration. The following sections present the impacts associated with the use of simulants and countermeasures.

Air Quality

The development and use of simulants, countermeasures, and drones could impact air quality in the biome where the action would occur. The prelaunch activities where the simulants, countermeasures, and drones are assembled and prepared for use would result in the emissions of Federal or state-listed criteria pollutants, as well as potential HAP emissions. The HAPs that may be released would depend on the chemical composition of the simulant or countermeasure, or the materials associated with the drones. The use of simulants, countermeasures, and drones during test events would result in emissions to the air; however, based on the parameters of the specific test, the emissions may be at an elevation above 914 meters (3,000 feet) and would not affect ground level air quality. Based on the chemical composition and volume of the simulant, or the composition and volume of volatile substances in the countermeasure component or drone, the emissions above 914 meters (3,000 feet) may impact air quality in terms of ozone depletion (particularly in the upper troposphere and stratosphere), acid rain, and global warming. Existing impact analyses prepared in accordance with NEPA and standard operating procedures would be reviewed to ensure that the activities would not result in a significant impact. Site-specific environmental analysis would be completed to evaluate potentially significant impacts.

Airspace

The use of delivery systems (boosters) for the simulants and countermeasures, as well as the simulants and countermeasures themselves could impact airspace of the biome where the action would occur. The operating altitudes, lateral orientation, specific type of airspace, and the region of influence are the parameters of specific test scenarios that influence the degree of the impact on airspace. The use of simulants and countermeasures may increase the duration and severity of impact on a particular airspace. The impacts of specific simulants and countermeasures on airspace would be reviewed in accordance with NEPA.

Biological Resources

The development and use of simulants and countermeasures could impact biological resources of the biome where the action would occur. Should the impacts affect a threatened or endangered species or its habitat, essential fish habitat, or jurisdictional wetlands, or another regulated resource then in addition to analysis under NEPA, compliance with other applicable laws (e.g., Clean Water Act, Endangered Species Act, Marine Mammal Protection Act, Migratory Bird Treaty Act, and Bald and Golden Eagle Protection Act), as well as regulatory agency consultation could be required.

Geology and Soils

The development and use of simulants and countermeasures would not impact geology; however, such activities could impact soils in the biome where the action would occur. The impact would result from the deposition of the simulants or countermeasures on the soil. The severity of the impact would be based on the composition of the simulant or countermeasure. The impacts related to the use of new simulants or countermeasures would be evaluated as necessary in accordance with NEPA.

Hazardous Materials and Hazardous Waste

The development and use of simulants and countermeasures could result in an impact from the use of hazardous materials and the generation of hazardous waste. A wide variety of hazardous materials may be used in the development of simulants and countermeasures including solvents, and toxic metals and substances. No radioactive materials would be used in the development and use of simulants and countermeasures. The development and use of specific simulants and countermeasures would include a life cycle analysis of potential impacts, including specific decommissioning activities for any hazardous materials. Hazardous materials or hazardous waste associated with the use of a simulant or countermeasure would be handled in accordance with installation and range specific protocols and appropriate regulations. Federal military ranges have established procedures in accordance with Federal regulations to ensure proper handling and use of these hazardous materials. These procedures would be reviewed to ensure that they address the appropriate hazardous materials. An evaluation of the potential impacts in accordance with NEPA and other relevant regulations would occur if the use of a simulant or countermeasure would utilize hazardous materials or generate hazardous waste not addressed in installation specific protocols. All hazardous waste generated would be disposed of in accordance with appropriate state and Federal regulations. The personnel involved in hazardous material operations would be trained in the appropriate procedures and would use appropriate personal protective clothing and would be up-to-date on any specialized training in hazardous material handling, spill containment and cleanup, or other hazardous material activities.

Health and Safety

The development and use of simulants and countermeasures could impact health and safety. Impacts on health and safety are not associated with particular biomes; rather they are associated with the processes and activities that would be implemented under a specific action. Health and safety impacts would be commensurate with the chemical composition of the simulant and the operating parameters involved with the use of simulants and countermeasures. New standard operating procedures that address safe handling and operational requirements to protect public health and safety would be developed for new or modified simulants and countermeasures. Such plans would

address health and safety issues for general operation and handling, as well as health and safety operations for system and operational testing and failures. The personnel who would operate and handle such equipment would be familiar with the standard operating procedures and would receive specific training as necessary. These actions would be performed in accordance with health and safety requirements of the specific installation or test range, which are specifically designed to protect public heath and safety.

Noise

The development and use of simulants or countermeasures would not impact noise within any biomes because these activities do not generate noise. The noise associated with the delivery system (i.e., booster) of a simulant or countermeasure is presented in Weapons – Interceptors.

Transportation

The development and the use of simulants would not impact transportation. As indicated in Section 4.1.1.2, short-term road closures along launch trajectories, the issuance of NOTAMs and NOTMARs to notify pilots and mariners of area closures, and debris recovery activities would not be expected to impact transportation.

Water Resources

The development and use of simulants and countermeasures could impact water resources in the biome where the action would occur. The severity of the impacts would depend on the chemical composition of the simulant or countermeasure. Impacts would occur from the deposition of simulants and countermeasures on surface waters, or from simulants migrating through soils to ground water. The disposal of simulants or countermeasures would follow appropriate protocols for the composition of the simulants and countermeasures. Prior to using simulants or countermeasures that may impact water resources, the impacts related to the specific chemical composition and operational testing environment would be analyzed in accordance with NEPA. Compliance with Federal and state regulations also would be required.

Orbital Debris

If countermeasures are used and remain on-orbit, they have the potential to disrupt or damage other space-based assets (e.g., communication satellites). However, orbiting objects lose energy through friction with the upper atmosphere and various other orbit perturbing forces. Over time, objects including countermeasures, may drop into progressively lower orbits and may eventually fall to Earth. As the object’s orbital trajectory draws closer to Earth, it speeds up and outpaces objects in higher orbits. Once

the object enters the measurable atmosphere, atmospheric drag will slow it down rapidly and cause it either to burn up or deorbit and fall to Earth.

4.1.2 Test Integration

Test integration considers the range of integrated testing activities the BMDS proposes to implement to transition from the testing of individual components to the evaluation of how they will work together and perform as the BMDS. Modeling, simulation, and analysis; MDIE; and integrated missile defense wargames are virtual tests (modeling and computational analyses) or software compatibility and communication tests that would be conducted within existing laboratory or test facilities. Because of the nature of these tests, no significant impacts would occur in any biome. However, activities associated with GTs and SIFTs would have the potential for environmental impacts.

GTs test components for interoperability. Such tests would assess and evaluate the C2BMC integration of the various components as well as the assimilation and use of the various sensors tracking system data. No laser weapons would be activated and no interceptors would be launched during GTs. To conduct these tests, multiple sensors and C2BMC components could be used from land-, air-, sea-, and space-based operating environments that would coordinate the control and transfer of information between weapons based on land, sea, and in the air. These sensors and C2BMC components could be activated from within the same biome or across several biomes.

For purposes of this analysis, two representative scenarios that could be used for SIFTs were considered. These two scenarios involve similar activities (launches of targets, use of multiple sensors, and use of land-, sea-, and air-based weapons); however, they differ in number of target launches and number of weapons used. Both scenarios may be used to support the proposed BMDS and are analyzed in this PEIS.

SIFT Scenario 1 – Single Weapon with Intercept represents the simplest SIFT and would include the launch of a single target and use of a single weapon component to intercept the target. This scenario would use multiple sensors and C2BMC components as described for GTs. Under SIFT Scenario 1, the launch of the target and the activation of a laser or launch of an interceptor may occur within the same biome (e.g., all within the Desert Biome) or may involve multiple biomes (e.g., target launch from the Tropical Biome and laser activation or interceptor launch in the BOA). As BMDS capabilities are proven, a second SIFT Scenario is envisioned that would build upon SIFT Scenario 1.

SIFT Scenario 2 – Multiple Weapons with Multiple Intercepts would include the launch of up to two targets. For each target launch, more than one weapon component (land-, sea-, or air-based) would be able to engage or “take a shot” at the target. Dual-target or interceptor launches would occur within seconds or minutes of each other. As with SIFT Scenario 1, numerous sensor components also would acquire the target and relay tracking

data. Under this test scenario, the two targets may be launched from one biome and the weapons may be activated or launched from the same or different biomes.

Environmental Consequences

Component testing would continue to occur under Alternative 1. These component tests would be conducted in addition to the proposed System Integration Tests. SIFTs would generally be designed around planned component flight tests. However, MDA may schedule additional tests that are not part of previously planned flight tests. Therefore, the total number of target and interceptor launches and laser, sensor, and C2BMC activation events would increase when compared to the No Action Alternative. This would increase the total number of tests, and thus the magnitude of environmental impacts.

The environmental consequences associated with the use of BMDS components under Alternative 1 are analyzed in Section 4.1. Impacts from activities that are discussed earlier in this PEIS will not be discussed in this section. Therefore, the analysis of System Integration Tests will focus on those environmental impacts that are unique to these types of tests. For this programmatic analysis, a qualitative impact assessment was completed for each resource area because specific System Integration Test parameters have not been developed that would provide quantitative values.

The activities associated with each type of System Integration Test analyzed in this PEIS include

- **Integrated GTs**. The activation of multiple sensors and C2BMC components, and passive activation of weapons (e.g., powering the tracking and communication aspects of the weapons system but not firing the weapon) within the same biome or across several biomes, which would coordinate the control and transfer of information between land-, sea-, and air-based weapons.

- **SIFT Scenario 1 – Single Weapon with Intercept**. The activation of multiple sensors and C2BMC components within the same biome or across several biomes coupled with the launch of one target and the activation of a laser or launch of an interceptor, and the debris from an intercept. Because the impacts associated with the use of multiple sensors and C2BMC components is discussed for GTs, this portion of the impacts analysis will not be repeated for this scenario.

- **SIFT Scenario 2 – Multiple Weapons with Multiple Intercepts**. The activation of multiple sensors and C2BMC components within the same biome or across several biomes coupled with the launch of up to two targets from the same biome or different biomes, the activation or launch of multiple weapons in the same biome or multiple biomes, and the debris from each intercept. Because the impacts associated with the

use of multiple sensors and C2BMC components are discussed for GTs, this portion of the impacts analysis will not be repeated for this scenario.

4.1.2.1 Air Quality

Integrated GTs

The emissions from generators required to power sensor and C2BMC systems could impact air quality. However, these generators would only be operated for a short time and the emissions associated with the activation of one generator would be a small fraction of *de minimis* thresholds. Activating multiple generators in a single biome or across multiple biomes would not have a significant impact on air quality.

The activation of radars, infrared, and optical sensors would not impact air quality. Leaks of inert gases, such as helium, N_2, and CO_2, from gas propellant laser sensors could occur; however, a leak of these gases to the atmosphere would be insignificant relative to ambient oxygen concentrations. There are no air emissions associated with the activation of solid-state lasers; therefore, no impacts to air quality would be expected. An increase in the number of laser sensors activated during GTs would not have a significant impact on air quality regardless of whether the sensors were located in the same or multiple biomes.

SIFT Scenario 1 – Single Weapon with Intercept

In addition to the impacts presented under GTs, the emissions from SIFT Scenario 1 would include emissions from activation of lasers and launches. The primary exhaust products of boosters and lasers would be as described for weapons components. An intercept would result in the release of gases and PM.

For a target launch and the activation of a laser or launch of an interceptor occurring in the same biome, the emissions from laser activation and launches combined with the release of gases and particulates from an intercept could impact air quality. Exhibit 4-11 shows the combined emission products from the launch of a representative target and interceptor within the same biome. Exhibit 4-12 shows the emission products from the launch of a representative target and the activation of a laser within the same biome. Emissions from launch activities and laser activation would not be expected to result in significant impacts to air quality. EPA uses six criteria pollutants as indicators of air quality, including ozone, CO, NO_2, SO_2, PM, and lead, and has established a maximum concentration for each, above which adverse effects on human health may occur. Of these pollutants, only CO is emitted during the launch of targets and the launch or firing of weapons. The *de minimis* level for CO is 91 metric tons (100 tons) per year. As shown in Exhibits 4-11 and 4-12, CO levels for the launch of a target and a launch of an interceptor would be only three percent of the *de minimis* level. The CO levels for the

launch of a target and the activation of a laser also would be less than two percent of the *de minimis* level. The magnitude of potential impacts from other emissions from launch and laser activation would depend on the biome in which the activities took place and would be analyzed in site-specific analyses. Impacts to air quality from laser activation and launches occurring in different biomes would not have the additive impacts of activities occurring within the same biome.

Exhibit 4-11. Emission Products from Launches of Representative Targets and Interceptors in metric tons (tons)

Emission Product	Target	Interceptor	Total
Al_2O_3	2.30 (2.54)	3.01 (3.32)	5.31 (5.85)
CO	1.75 (1.93)	0.98 (1.08)	2.73 (3.01)
HCl	1.73 (1.91)	1.77 (1.95)	3.50 (3.86)
N_2	0.68 (0.75)	5.77 (6.36)	6.45 (7.11)
H_2O	0.92 (1.02)	1.93 (2.13)	2.85 (3.15)
H_2	0.16 (0.17)	0.00 (0.00)	0.16 (0.17)
CO_2	0.34 (0.37)	1.47 (1.62)	1.81 (1.99)
Other	0.00 (0.00)	0.16 (0.18)	0.16 (0.18)

Source: Dailey, 1993 as referenced in U.S. Army Space and Strategic Defense Command, 1994d and U.S. Army Space and Missile Defense Command, 2003.

Exhibit 4-12. Emission Products from Launches of Representative Targets and Lasers in kilograms (pounds)

Emission Product	Target	Laser	Total	Total metric tons (tons)
Al_2O_3	2,300 (5,060)	-	2,300 (5,060)	2.30 (2.54)
CO	1,747 (3,846)	-	1,747 (3,846)	1.75 (1.93)
HCl	1,733 (3,815)	-	1,733 (3,815)	1.73 (1.91)
N_2	680 (1,497)	108 (238)	788 (1735)	0.79 (0.87)
H_2O	924 (2,033)	540 (1,190)	1464 (3223)	1.46 (1.61)
H_2	156 (344)	23 (51)	179 (395)	0.18 (0.20)
CO_2	336 (739)	396 (873)	732 (1612)	0.73 (0.81)
Oxygen	-	270 (595)	270 (595)	0.27 (0.30)
Cl	-	36 (79)	36 (79)	0.04 (0.04)
Ammonia	-	81 (179)	81 (179)	0.08 (0.09)
Iodine	-	13 (29)	13 (29)	0.01 (0.01)

Source: U.S. Army Space and Strategic Defense Command, 1993c; Dailey, 1993 as referenced in U.S. Army Space and Strategic Defense Command, 1994d and U.S. Department of the Air Force, 1997b

SIFT Scenario 2- Multiple Weapons with Multiple Intercepts

In addition to the impacts presented under SIFT Scenario 1, the emissions from launching any two targets (liquid- or solid-propellant) from the same location at the same time would not be expected to result in significant impacts to air quality, provided that such an activity is within the operating parameters of the launch facility or range. The launch or activation of multiple weapons and use of additional support equipment would result in a localized increase in emissions. The concentration of the localized emissions and the subsequent severity of the impact would vary based on the number of launches or activations and support equipment, the proximity (both geographically and in time) of each launch or activation and operation of support equipment, and the specific location of such activities within a biome. The combined impacts of all the emissions associated with SIFT Scenario 2 (emissions from support equipment, launches, laser activations, and debris from intercepts) might result in significant impacts to air quality. Site-specific environmental analysis would be completed to evaluate potentially significant impacts.

4.1.2.2 Airspace

Integrated GTs

EMR and other radio frequency transmissions associated with radar sensors and C2BMC equipment activated during GTs could potentially impact airspace operations by interfering with communication and navigation equipment. Coordination with the appropriate FAA ARTCC, relevant military installations, and relevant foreign countries with jurisdiction over affected airspace would minimize the potential for impact from these tests.

In addition, laser sensors have the potential to cause eye damage to aircraft pilots. All laser sensors would be operated according to appropriate range safety regulations. An increase in the number of laser sensors activated during GTs would not be expected to significantly impact airspace.

SIFT Scenario 1 - Single Weapon with Intercept

In addition to the impacts presented under GTs, the impacts associated with airspace from SIFT Scenario 1 would include the additional restricted airspace associated with launches and the activation of lasers. Launches of targets and the activation or launch of a weapon, and impact of the target and interceptor would occur in designated areas of cleared airspace. Close coordination with the appropriate FAA ARTCC, relevant military installations, and foreign countries with jurisdiction for airspace management would minimize the potential for any adverse impacts on airspace use and scheduling. In addition, before conducting an operation that is potentially hazardous to non-participating aircraft, NOTAMs would be issued.

Retrieval of debris on land would occur within the boundaries of the designated impact area; therefore, debris retrieval would have no impact on navigable airspace or airborne activities outside the restricted airspace complex. It is not anticipated that debris falling into the BOA would be retrieved.

SIFT Scenario 2 – Multiple Weapons with Multiple Intercepts

In addition to the impacts presented under SIFT Scenario 1, the additional impacts to airspace under SIFT Scenario 2 would result from a larger portion of cleared airspace required to support the specific SIFT, the increased duration of the test, the additional debris areas associated with two targets and multiple intercept attempts, and increased operation of support equipment, which could result in an increase in the disruption of commercial and civilian air travel and operations. Close coordination with the appropriate FAA ARTCC, military installations, and relevant foreign countries with jurisdiction over affected airspace would reduce the potential impacts to airspace. Upon completion of such coordination for each test, there would be no significant impacts to airspace.

4.1.2.3 Biological Resources

Integrated GTs

Impacts to biological resources resulting from GTs would include EMR emissions from radar sensors and laser beams from laser sensors. The size, motion, and orientation of the beams would limit the beam exposure time on biological resources. An increase in the number of radar sensors operating within a biome would increase the risks to biological resources, but the impacts would be insignificant.

SIFT Scenario 1 – Single Weapon with Intercept

In addition to the impacts presented under GTs, the impacts from SIFT Scenario 1 would include the emissions associated with activation of lasers, including CO_2, ammonia, and chlorine. Such impacts are considered to be minor as the laser would be operated for a few seconds per launch, and would not emit large quantities of gases. Potential impacts from launches include emissions, deposition of hazardous materials, debris associated with intercepts, and noise associated with launch and flight. Impacts to biological resources associated with SIFT Scenario 1 activities would result primarily from the noise associated with launch and intercept. Sonic booms may create startle responses in some animals. Debris from the intercept could directly hit an animal. Coordination and consultation with appropriate regulatory agencies, as well as adherence to appropriate and relevant international treaties, would be required to address any potentially significant impacts on biological resources. Impacts to biological resources would depend on the

biome in which the launch and intercept took place. The potential for and extent of impact would need to be examined in site-specific environmental analysis.

SIFT Scenario 2 – Multiple Weapons with Multiple Intercepts

In addition to the impacts presented under SIFT Scenario 1, the environmental impacts to biological resources under SIFT Scenario 2 are related to the biome and the threatened and endangered species, the unique or sensitive environments, and the migratory, breeding, and feeding activities that occur in the biome, which would be affected by such activities. Site-specific environmental analysis would be completed to evaluate potentially significant impacts.

4.1.2.4 Geology and Soils

Integrated GTs

Impacts to geology and soils as a result of GTs would be limited to fuel spills associated with generators. Appropriate control, handling, and clean up procedures would be in place for any hazardous material spills or leaks. An increase in the number of sensors or C2BMC systems tested within a biome would not significantly increase the impacts to geology and soils.

SIFT Scenario 1- Single Weapon with Intercept

In addition to the impacts presented under GTs, the impacts from SIFT Scenario 1 would include increased soil acidity from the emission of small amounts of chlorine if the laser is activated in a humid biome. Similarly, HCl emitted primarily from launch of solid propellant boosters could be deposited on the soil in the form of acid rain and result in increased soil acidity.

Impacts to geology and soils also may result from the emissions and subsequent deposition of PM and any simulant used in the target. A target launch and the activation or launch of a weapon would not result in a significant impact to geology and soils.

SIFT Scenario 2 – Multiple Weapons with Multiple Intercepts

The activities performed under SIFT Scenario 2 would not impact geology. In addition to the impacts presented under SIFT Scenario 1, the environmental impacts to soils under SIFT Scenario 2 would be related to the biome, the characteristics and condition of the soil, and the type and amount of material that would be deposited on the soil during a test event. Site-specific environmental analysis would be completed to evaluate potentially significant impacts.

4.1.2.5 Hazardous Materials and Hazardous Waste

Integrated GTs

GTs would involve an increase in the volume of hazardous materials and hazardous wastes used and generated by the testing of sensors and C2BMC systems. However, hazardous materials and hazardous waste would be handled in accordance with all applicable regulations, and each test location would have an SPCC plan in place to handle any spills or leaks of hazardous materials. An increase in the use of sensors and communication systems in a biome would not result in significant impacts from hazardous materials and hazardous waste.

SIFT Scenario 1 – Single Weapon with Intercept

SIFT Scenario 1 would potentially increase the impacts from hazardous materials and hazardous waste. The impacts from laser activation would include the production of spent laser chemicals, which would be neutralized and treated as waste. Potential impacts from launches include fueling procedures (if applicable) and debris disposal. Appropriate waste management and disposal procedures would be in place to safely manage these substances in accordance with applicable regulations.

For a target launch and the activation of a laser or launch of an interceptor, impacts from hazardous materials and hazardous waste would not result in a significant impact. Applicable regulations and procedures would be followed and would prevent impacts from management and disposal of hazardous materials or hazardous waste. If appropriate, debris from launches would be handled in accordance with approved disposal requirements.

SIFT Scenario 2 – Multiple Weapons with Multiple Intercepts

The activities under SIFT Scenario 2 would use more hazardous materials and would generate more hazardous waste than those under SIFT Scenario 1. The increased use and generation of hazardous materials and hazardous waste would not result in a significant impact. Hazardous materials and hazardous waste including debris (if appropriate) would be handled in accordance with approved disposal requirements.

4.1.2.6 Health and Safety

Integrated GTs

Operation of multiple sensors and C2BMC systems during GTs would increase potential risks to health and safety. All health and safety procedures would be followed in the operation of the sensors and C2BMC systems. Appropriate safety exclusion zones,

personnel exclusion zones, and EMR hazard zones would be established prior to testing. All participating personnel would be trained and certified in the risks associated with testing and operation of sensors and C2BMC systems. As a result, the increase in risks to health and safety would not be considered significant.

SIFT Scenario 1 – Single Weapon with Intercept

The potential impacts associated with SIFT Scenario 1 would increase the exposure to health and safety risks from those found in the GTs. Impacts would include potential impacts from laser operation including handling laser chemicals and potential contact with the laser beam. Potential impacts to health and safety from launches include exposure to explosives, contact with launch debris, and exposure to noise produced during launch.

Impacts to health and safety from activities associated with SIFT Scenario 1 would depend on the biome in which launches and intercept took place. Because launches would take place on facilities or at locations with restricted access, members of the public would not be exposed to these hazards. Operating procedures would be developed to protect personnel, reducing any potential impacts to less than significant levels. Individuals exposed to health and safety risks would be DoD or DoD contractor personnel, other participants in the test, and other support, security, or observer personnel. All personnel exposed to elevated health and safety risks would be trained and certified for such risks, while the remaining test personnel would be briefed on the health and safety risks in accordance with appropriate and relevant regulations and standard operating procedures. The establishment of restricted impact areas and adherence to applicable regulations and standard operating procedures would reduce impacts from debris to less than significant levels.

SIFT Scenario 2 – Multiple Weapons with Multiple Intercepts

The activities associated with SIFT Scenario 2 would result in an increased exposure to health and safety risks in comparison to those associated with SIFT Scenario 1. The increased exposure to health and safety risks associated with SIFT Scenario 2 would not be expected to result in a significant impact.

4.1.2.7 Noise

Integrated GTs

Impacts from noise as a result of GTs would be limited to noise associated with the operation of generators required to activate sensors and C2BMC. Noise impacts from generators would be dependent on the intensity, the duration, and the proximity of the noise to sensitive receptors. The generators would be operated during tests, and sea- and

air-based systems typically would not be operated in proximity to sensitive receptors. Site-specific environmental analysis would be completed to evaluate potentially significant impacts. However, in general, the increase in noise from multiple generator use within a biome would not be significant.

SIFT Scenario 1 – Single Weapon with Intercept

Potential impacts from noise associated with SIFT Scenario 1 would be greater than those associated with GTs. For a target launch and the activation of a laser or launch of an interceptor, up to two sonic booms would be generated. The sonic booms could each produce overpressures as high as 8 to 16 pounds per square foot; however, these would be of short duration, lasting up to several milliseconds. Noise produced above 12,192 meters (40,000 feet) would not affect ground level noise. In addition, launches would occur at locations where members of the public would not be exposed to launch noise in excess of OSHA regulations. Personnel associated with launch would either be removed from the launch location or would use hearing protection to reduce exposure to less than significant levels. Impacts would be dependent on the biome in which launches and intercept took place. However, in general, noise associated with SIFT Scenario 1 would not be significant.

SIFT Scenario 2 – Multiple Weapons with Multiple Intercepts

The activities under SIFT Scenario 2 would result in increased noise levels when compared to SIFT Scenario 1. Activities under SIFT Scenario 2 will be evaluated for noise on a case-by-case basis.

4.1.2.8 Transportation

Integrated GTs

Impacts to transportation as a result of GTs would be limited to those associated with radar sensors. Air and marine transportation could be impacted by EMR emissions. Impacts to air transportation are described in Airspace. For marine transportation, NOTMARs would be issued in advance of the testing event to allow vessels to plan alternate routes to avoid the EMR hazard areas. The activation of multiple sensors in a biome would not significantly impact transportation.

SIFT Scenario 1 – Single Weapon with Intercept

In addition to the impacts presented under GTs, potential impacts to transportation from SIFT Scenario 1 would include temporary road closures around launch sites, expected flight trajectories, and debris impact zones. Debris recovery on land would require a relatively small number of vehicles. For SIFT Scenario 1 activities, areas around the

launch sites, the expected flight trajectories, and debris impact zone would be affected. However, closures of roads, airspace, and marine areas would be of short duration and would be considered routine occurrences for launch sites. Issuance of NOTAMs and NOTMARs would allow vehicles to clear the affected areas. All transportation of the components and support assets would be completed in accordance with the appropriate and relevant national and international standards and requirements. Therefore, no significant transportation impacts would be expected.

SIFT Scenario 2 – Multiple Weapons with Multiple Intercepts

The increase in transportation requirements or any increases in the frequency, duration, or number of transport route closures that would be required under SIFT Scenario 2 would not result in a significant transportation impact. All closures would be coordinated through the appropriate authorities.

4.1.2.9 Water Resources

Integrated GTs

GTs would involve an increase in risk for hazardous materials and hazardous waste spills and an increase in demand for potable water. Spills and leaks of hazardous materials and hazardous waste would be handled according to appropriate regulations and to the spill plans at each test site. Potable water supplies could be impacted, especially in areas with limited water supplies and infrastructure. The increase in personnel in these areas associated with GTs could exceed the capacity of the available potable water supply infrastructure. Site-specific environmental analysis would be completed to evaluate potentially significant impacts. However, in general impacts to water resources would not be significant.

SIFT Scenario 1 – Single Weapon with Intercept

Impacts to water resources from SIFT Scenario 1 would add to those associated with GTs. Impacts would include the generation of HCl from laser activation and launches of some boosters. For a target launch and the activation of a laser or launch of an interceptor occurring in the same biome, impacts to water resources would be dependent on the biome in which the launches and intercept took place. An early flight termination could result in propellant and debris from the target and interceptor being deposited in water bodies. Specific impacts on water resources are related to the biome and the unique or sensitive environments (wetlands, marine sanctuaries, essential fish habitat) that occur in the biome, which would be affected by such activities. Coordination and consultation with appropriate regulatory agencies would be required to address any potentially significant impacts on water resources. Impacts to water resources from laser

activation and launches occurring in different biomes would not have additive impacts of activities occurring within the same biome.

SIFT Scenario 2 – Multiple Weapons with Multiple Intercepts

In addition to the impacts presented under SIFT Scenario 1, the environmental impacts on water resources under SIFT Scenario 2 would result from increased pollutant emissions and subsequent deposition associated with the launches and successful intercepts or flight terminations. Site-specific environmental analysis would be completed to evaluate potentially significant impacts.

4.1.2.10 Orbital Debris

Integrated GTs

The amount of orbital debris would not be impacted by GTs.

SIFT Scenario 1 – Single Weapon with Intercept

The amount of orbital debris could increase under SIFT Scenario 1, from GMD or boost phase intercepts in the upper atmosphere. Such increases in orbital debris would be temporary, as studies indicate that objects in orbit between 200 and 399 kilometers (123 to 248 miles) reenter the atmosphere within a few months. (Interagency Group [Space], 1989, as referenced in U.S. Department of the Air Force, 1998)

Orbiting objects lose energy through friction with the upper reaches of the atmosphere and various other forces. Over time, the object falls into progressively lower orbits and eventually falls to Earth. As the object's orbital trajectory draws closer to Earth, it speeds up and outpaces objects in higher orbits. Once the object enters the measurable atmosphere, atmospheric drag will slow it down rapidly and cause it either to burn up or deorbit and fall to Earth.

NASA has determined that a significant amount of debris does not survive the severe heating that occurs during reentry. (NASA, 2003a) Components that do survive are most likely to fall into the oceans or other bodies of water or onto sparsely populated regions. During the past 40 years an average of one cataloged piece of debris fell back to Earth each day. No serious injury or significant property damage caused by reentering debris has been confirmed. Although it cannot be determined with certainty how much debris would be produced under SIFT Scenario 1, the fact that the orbital debris would only be on orbit for a limited time, the majority of the orbital debris would burn up upon reentry into the Earth's atmosphere, other orbital debris that falls to Earth daily has not caused injury or significant property damage indicates that orbital debris associated with SIFT Scenario 1 would not pose significant impacts.

SIFT Scenario 2 – Multiple Weapons with Multiple Intercepts

Increases in orbital debris would be greater under SIFT Scenario 2 than SIFT Scenario 1. Under SIFT Scenario 2 additional space-based sensors and C2BMC assets would be used and therefore these platforms could also produce orbital debris. As with SIFT Scenario 1, it may also be possible for debris from boost or midcourse intercepts to become orbital debris until it reenters the Earth's atmosphere. As defined under SIFT Scenario 1, the orbital debris would not pose a significant impact.

4.1.3 Activities at Locations Outside of the Continental U.S.

Some MDA activities may occur outside the continental U.S. (OCONUS), its territories and possessions. Because NEPA and other environmental laws do not generally apply to OCONUS activities, various EOs and DoD directives and instructions have been implemented. Appendix G describes the framework within which the MDA activities must comply regarding these international activities.

Impacts Analysis for MDA OCONUS Activities and Facilities

To conduct an analysis of potential impacts from proposed OCONUS BMDS activities, MDA considered global biomes based on similar ecological characteristics rather than political boundaries. The activities conducted in international locations would have the same emissions and stressors on resource areas as those conducted within the U.S. and its territories, e.g., types and amounts of emissions and noise from booster launches. However, the receiving environment may be very different and international regulatory requirements may have different standards for what constitutes a trigger for significance of impacts. The framework in terms of overseas environmental planning and compliance issues is addressed in Appendix G.

4.1.4 Cumulative Impacts

The proposed action addressed in this PEIS is the development, testing, deployment, and planning for decommissioning for an integrated BMDS to protect the U.S., its allies, and its interests worldwide. Thus this action is worldwide in scope and potential application, and only activities similar in scope have been considered for cumulative impacts. Regional or local past, present, or future activities would be considered for cumulative impact assessment as appropriate, during subsequent site- or action-specific NEPA analyses. Worldwide launch programs for commercial and government programs were determined to be activities of international scope that might reasonably be considered for cumulative impacts in this PEIS. Launches can contribute to cumulative impacts in three specific areas – ozone depletion, global warming, and orbital debris.

The number of BMDS projected launches was estimated at 515[54] during the years 2004 to 2014. Worldwide projected launches, which include 77 U.S. commercial launches (FAA AST, 2003); 99 U.S. government launches (NASA, 2003a; NASA, 2003b; NASA, 2003c); 183 foreign commercial launches (COMSTAC, 2003); and 476 foreign government launches (NASA, 2004; Gunter's Space Page, 2004; Spaceflight Now, 2004a; Spaceflight Now, 2004b), were estimated to total 835 launches during the years 2004 and 2014.

Exhibit 4-13 summarizes both BMDS and other worldwide launch emission loads to the stratosphere, based on the projected number of launches identified above. Note that the load to the troposphere would be the same as the load to the stratosphere because the residence time is assumed to be the same and the propellant types used are assumed to be the same (see Appendix I for assumptions used to estimate launch emissions loads).

Exhibit 4-13. Summary of Estimated Emission Loads to the Stratosphere from Launches (2004-2014) in metric tons (tons)*

	HCl	Al_2O_3	CO_2	H_2O	N_2	Cl	NO_X	CO
BMDS Projected Launches	1,344 (1,481)	2,432 (2,680)	3,118 (3,436)	1,810 (1,994)	0 (0)	18 (20)	1,821 (2,006)	0 (0)
Worldwide Projected Launches	6,526 (7,192)	11,777 (12,979)	57,287 (63,130)	50,298 (55,429)	0 (0)	87 (96)	94,933 (104,616)	0 (0)
Total Projected Launches	7,870 (8,673)	14,210 (15,659)	60,404 (66,566)	52,108 (57,413)	0 (0)	105 (116)	96,754 (106,623)	0 (0)

*Calculations subject to rounding; see Appendix I for additional information on launch emission load calculations and related assumptions

Global Warming

Potential launch emissions that could affect global warming include CO and CO_2. Unlike CO_2, CO is not a greenhouse gas; however, it can contribute indirectly to the greenhouse gas effect and is therefore included in this analysis. The cumulative impact on global warming from launches would be insignificant compared to other industrial sources (e.g., energy generation using fossil fuel) and activities (e.g., deforestation and land clearing). Estimated BMDS launch emissions load of CO and CO_2 to the troposphere and stratosphere would account for only five percent of the emissions load from launches worldwide. However, even when accounting for both BMDS launches and other launches worldwide, the CO and CO_2 load would be extremely small compared to

[54] Projected number of launches based on MDA estimates.

emissions loads from other industrial sources just in the U.S. As Exhibit 4-14 indicates, the amount of CO and CO_2 emissions load from all launches over the ten-year period under consideration would account for 3.5×10^{-4} percent of CO and CO_2 emissions load from U.S. industrial sources in one year.

Exhibit 4-14. Comparison of Emission Loads of CO and CO_2 to both the Troposphere and Stratosphere

Emission Sources	CO and CO_2 Emissions in metric tons (tons)*
BMDS Projected Launches from 2004-2014	6,235 (6,871)
Worldwide Projected Launches from 2004-2014	114,573 (126,260)
Other Industrial Sources in the U.S.**	34 billion (37.6 billion) for one year 136.3 billion (150.2 billion) for four years

* Calculations subject to rounding
** Source: EPA, 2003d

Ozone Depletion

Ozone depletion is a major concern, as the stratospheric ozone layer protects the Earth from adverse levels of ultraviolet radiation. Chlorine is a chemical of primary concern with respect to ozone depletion. Launches are one of the human-made sources of chlorine in the stratosphere. The cumulative impact on stratospheric ozone depletion from launches would be far below and indistinguishable from the effects caused by other natural and man-made causes. Projected BMDS launches would include boosters considerably smaller than those used on the Space Shuttle; therefore, the air quality impacts from the Space Shuttle provide a conservative upper bound for comparison.

As Exhibit 4-15 indicates, the emission loads of chlorine (as HCl and free Cl) from both BMDS and other launches worldwide as projected from 2004-2014 would account for only 0.5 percent of the industrial Cl load from the U.S. over the 10-year period. The majority of the chlorine load from launches is as HCl, which does not readily break down into the ozone-depleting substance Cl. Also, the HCl in the troposphere is usually quickly removed by water in the atmosphere. The emissions load of chlorine from launch activities would also be minimal in comparison to the 362,874 metric tons (400,000 tons) of inorganic chlorine created annually by photolysis of historical reservoirs of CFCs. (DOT, 2001b)

Exhibit 4-15. Comparison of Emission Loads of Chlorine (HCl and Free Cl) in both the Troposphere and Stratosphere

Emission Source	Cl Emissions in metric tons (tons)*
Projected BMDS Launches 2004-2014	2,724 (3,002)
Projected Worldwide Launches 2004-2014	13,226 (14,580)
Other Industrial Sources in the U.S 2004-2014**	2,993,694 (3,000,000)

* Calculations subject to rounding
**Source: Adapted from DOT, 2001b

Almost all of the studies to date on ozone depletion from launches are based upon homogenous gas phase chemistry, which does not address the effects from particulates and aerosols released during ascent. There are no commonly accepted models that accurately predict the effects from particulates and aerosols on ozone depletion caused by launches. Future analysis of launches using heterogeneous chemistry could significantly alter the understanding of cumulative impacts of launch emissions on stratospheric ozone depletion. There is some evidence that particulates may play a larger role in ozone-depletion reactions than has currently been demonstrated. If this were the case, assuming only homogeneous gas phase chemistry (i.e., no effects from particulates or aerosols), the amount of ozone depletion actually occurring as a result of emissions from launches would be underestimated.

Orbital Debris

Orbital debris would be produced by space-based BMDS sensors and space-based C2BMC components and could be produced by midcourse and boost phase intercepts with sufficient energy. The effects of orbital debris on other spacecraft would depend on the altitude, orbit, velocity, angle of impact, and mass of the debris. Debris less than 0.01 centimeter (0.004 inch) in diameter can cause surface pitting and erosion. Over a long period of time, the cumulative effect of individual particles colliding with a satellite might become significant because the number of particles in this size range is very large in LEO. Long-term exposure of payloads to such particles is likely to cause erosion of exterior surfaces and chemical contamination, and may degrade operations of vulnerable components such as optical windows and solar panels. Debris between 0.01 and 1 centimeter (0.004 and 0.4 inch) in diameter could cause significant impact damage that could be serious, depending on system vulnerability and defensive design provisions. Objects larger than 1 centimeter (0.4 inch) in diameter can produce catastrophic damage. Although it is currently practical to shield against debris particles up to one centimeter (0.4 inch) in diameter (a mass of one gram [0.05 ounce]), for larger debris, current shielding concepts become impractical. (Office of Science and Technology Policy, 1995, as referenced in U.S. Department of the Air Force, 1998)

Astronauts or cosmonauts engaging in extra-vehicular activities could be vulnerable to the impact of small debris. On average, debris one millimeter (0. 04 inch) in diameter is capable of perforating current U.S. space suits. (Cour-Palais, 1991, as referenced in Commission on Engineering and Technical Systems, 1995)

Solid rocket motors eject Al_2O_3 dust (typically less than 0.01 centimeter [0.004 inch] in diameter) into the orbital environment, and may release larger chunks of unburned solid propellant or slag. However, solid rocket motor particles typically either decay very rapidly, probably within a few perigee passages, or are dispersed by solar radiation pressure. Thus, the operational threat of solid rocket motor dust is probably limited to brief periods of time related to specific mission events. (Office of Science and Technology Policy, 1995, as referenced in U.S. Department of the Air Force, 1998)

Orbital debris generated by launch vehicles contributes to the larger problem of pollution in space that includes radio-frequency interference and interference with scientific observations in all parts of the spectrum. For example, emissions at radio frequencies often interfere with radio astronomy observations. (Office of Technology Assessment, 1990, as referenced in U.S. Department of the Air Force, 1998) Not only can orbital debris interfere with the performance of scientific experiments, but also it can even accidentally destroy them. (Scheraga, 1986, as referenced in U.S. Department of the Air Force, 1998)

Orbiting objects lose energy through friction with the upper reaches of the atmosphere and various other forces. Over time, the object falls into progressively lower orbits and eventually falls to Earth. As the object's orbital trajectory draws closer to Earth, it speeds up and outpaces objects in higher orbits. Once the object enters the measurable atmosphere, atmospheric drag will slow it down rapidly and cause it either to burn up or deorbit and fall to Earth.

NASA has determined that a significant amount of debris does not survive the severe heating that occurs during reentry. (NASA Orbital Debris Program, 2003) Components that do survive are most likely to fall into the oceans or other bodies of water or onto sparsely populated regions like the Canadian Tundra, the Australian Outback, or Siberia in the Russian Federation. During the past 40 years an average of one cataloged piece of debris fell back to Earth each day. No serious injury or significant property damage caused by reentering debris has been confirmed. Although it cannot be determined with certainty how much debris would be produced from BMDS activities, or how much debris is produced by worldwide launches annually, the fact that orbital debris reenters on a daily basis and this debris has not caused injury or significant property damage indicates that orbital debris produced by BMDS space-based sensors would not pose significant impacts. Therefore the cumulative impacts of orbital debris for Alternative 1 are expected to be less than significant.

4.2 Alternative 2 – Implement BMDS Using Land-, Sea-, Air-, and Space-Based Weapons Platforms

Alternative 2 includes the use of weapons from land-, sea-, air-, and space-based platforms. The impacts associated with the use of weapons from land, sea, and air platforms would be the same as discussed for Alternative 1. Therefore, the analysis for this alternative will focus only on the additional impacts of using weapons from space-based platforms. Although MDA has historically conducted research and development efforts on space-based lasers, these efforts have been put on hold as kinetic energy missile technology, which is more promising in the short term, is being pursued. Therefore, this PEIS only addresses space-based interceptor technology and any future application of lasers from a space platform would be addressed as required.

4.2.1 Impacts Analysis

If Alternative 2 were selected, additional environmental analysis could be needed as the technologies intended to be used become more defined and robust. Because the impacts associated with the use of interceptors from space-based platforms are not environment specific, the impacts analysis for this alternative will not discuss specific environments.

The life cycle activities for space-based interceptors would be as described in Section 4.1 and in Exhibit 4-3.

For purposes of impacts analysis for space-based interceptors it was assumed that all manufacturing activities impacts would be the same as those discussed for Alternative 1. Therefore, they are not discussed for Alternative 2.

Space-based interceptors would be launched on launch vehicles and maintained from platforms similar to other satellites used for DoD and commercial purposes in a prescribed orbit around the Earth. The launch vehicles used to insert the weapon platforms into the proper orbit would likely be existing launch vehicles; and therefore, the impacts of the launch would be as described for Support Assets.

The impacts associated with the use of space-based interceptors and debris and deorbiting are unique to space and are discussed in some detail in this section. The NEPA and EO 12114, which require review of the environmental impact of certain Federal actions, do not apply to impacts in space. However, this PEIS considers the impacts that space-based objects, including orbital debris, might have on the terrestrial environment. Therefore, this analysis will focus on the impact to Earth of the launch of interceptors and the reentry of orbital debris.

Interceptors

Interceptors may be used from space-based platforms. Although preliminary design and development has been considered for a space-based interceptor, in the future MDA may develop and test other space-based interceptor designs.

Space-based interceptors would most likely be placed in LEO via existing launch vehicles. The booster used on the space-based interceptor would be either a pre-fueled liquid propellant booster or a solid propellant booster, with properties similar to those interceptors described in Alternative 1. It is unlikely that a non-pre-fueled liquid propellant would be used on a space platform. The interceptor and platform would likely be composed of aluminum, magnesium, carbon resin composites, titanium, and limited quantities of beryllium.

Space-based interceptors would be capable of providing defense against threat missiles in all flight phases. Because of this, the launch scenario may direct the interceptor towards Earth along a trajectory to intercept a threat missile. In planning test activities, the MDA would select launch scenarios that would result in both the interceptor and the debris impacting in designated areas either in the ocean or on cleared land-based ranges. The space-based interceptors may also be equipped with an FTS that, in the event of a launch mishap, would be activated to destroy the interceptor. The resulting debris from the interceptor would be the same as that produced during a successful intercept and would be as discussed for other debris.

Orbital Debris

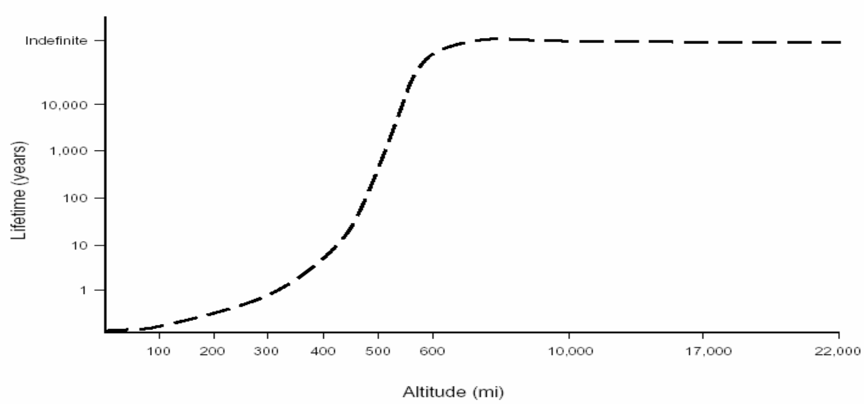
Orbital debris presents the most significant deviation from the impacts described for Alternative 1. Orbital debris generally refers to material that is on orbit as the result of space initiatives, but is no longer serving any function. Orbital debris can return to Earth via controlled or planned deorbiting or via uncontrolled deorbiting. Using interceptors from a space-based platform would create orbital debris, from successfully intercepting a threat missile and causing it to break up or from the break up of an unsuccessful interceptor or the space platform.

Space-based weapons platforms would contribute to orbital debris while in orbit and upon deorbiting, potentially hitting other satellites in their paths. The U.S. Air Force Space Command, located inside Cheyenne Mountain AFS, Colorado, tracks objects larger than 10 centimeters (4 inches) in diameter orbiting Earth. Space surveillance conducted by U.S. Space Command includes reentry assessment to predict when and where an object would reenter the Earth's atmosphere. U.S. Space Command does not, however, make surface impact predictions. NASA estimates that there are over 9,000 objects larger than 10 centimeters (4 inches) in diameter in space. The estimated population of particles between 1 and 10 centimeters (0.4 and 4 inches) in diameter is

greater than 100,000, and the number of smaller particles probably exceeds tens of millions. (NASA, 2001, as referenced in U.S. Department of the Air Force, 1998)

The addition of orbital materials from the operation of space-based weapons would contribute to the accumulation of orbital debris in LEO. Unless reboosted, satellites in orbits at altitudes of 200 to 399 kilometers (124 to 248 miles) reenter the atmosphere within a few months. At orbital altitudes of 399 to 900 kilometers (248 to 559 miles), orbital lifetimes can exceed a year or more depending on the mass and area of the satellite. Above 900-kilometer (559-mile) altitudes, orbital lifetimes can be 500 years or more. (Interagency Group [Space], 1989, as referenced in U.S. Department of the Air Force, 1998) Exhibit 4-16 shows the relationship between altitude and orbital lifetime.

Exhibit 4-16. Relationship between Altitude and Orbital Lifetime



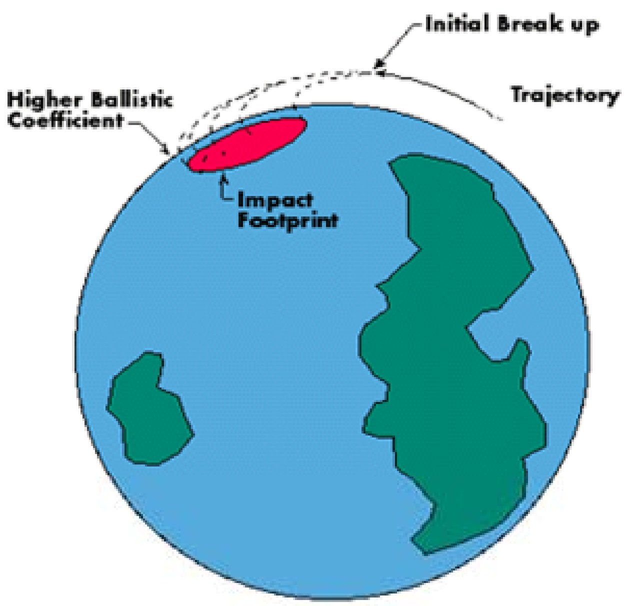
Debris in orbit gradually loses altitude. When orbiting objects enter dense regions of the atmosphere, friction between the object and atmosphere generates heat. This heat can melt or vaporize all or portions of the object resulting in minimal amounts of debris reaching the surface of the Earth. During reentry, the deceleration of the debris creates loads on the structure that can exceed ten times the acceleration of gravity. These loads combine with the high temperature to cause the debris to break apart.

Some debris can survive reentry heating. This occurs if the debris component's melting temperature is high, or if its shape enables it to lose heat fast enough to keep the temperature below the melting point. (Aerospace Corporation, Center for Orbital Reentry and Debris Studies, 2003) In general, components made of aluminum and other materials with low melting temperatures do not survive reentry, while components made of materials with high melting temperatures, such as stainless steel, titanium, and glass, often do survive. Large pieces with moderate melting temperatures can also survive reentry, radiating heat over their large surface areas. Pieces that survive reentry tend to

be large and in some cases heavy, posing a significant hazard to people and property within the bounds of the object's reentry debris footprint. (Aerospace Corporation, Center for Orbital Reentry and Debris Studies, 2003) When possible, debris impact areas would be carefully selected to include deep ocean areas or designated locations on military ranges. However, the majority of orbital debris burns on reentry and thus does not reach the Earth. It is unlikely that the impact of debris associated with an uncontrolled reentry would pose a significant threat to the environment on Earth.

Debris that survives reentry would impact within debris or impact footprints, i.e., the areas on the land or water surfaces that would contain all of the debris pieces. Debris is more likely to terminate in water than on land because water covers 75 percent of the Earth’s surface. Debris falling into water would produce impacts similar to those described for postlaunch activities in Alternative 1. It is possible to estimate the size of the impact footprint, but very difficult to predict precisely where the footprint would be on the Earth's surface or where specific pieces of debris would land. Exhibit 4-17 shows the various phases of reentry. After initial and subsequent breakups, surviving pieces of the reentering object would hit down in the debris or impact footprint area.

Exhibit 4-17. Typical Satellite Breakup



Source: Aerospace Corporation, Center for Orbital Reentry and Debris Studies, 2003

The size of the debris footprint is determined by estimating the breakup altitude of the orbiting object; then by estimating the mass and aerodynamic properties of surviving debris. Heavy debris would generally travel farther downrange within the debris footprint; lighter material would generally fall near the point of intercept. Footprint lengths can vary from 185 to 2,000 kilometers (115 to 1,243 miles), depending on the characteristics and complexity of the object.

The footprint width is generally determined by the impact of wind on the falling debris objects, with heavy objects less affected than lighter ones. The breakup process also may affect the width of the footprint. For example, if the object should explode during reentry, fragments would be spread out across the footprint. A footprint width of 20 to 40 kilometers (12 to 25 miles) is typical, with the most pronounced effects near the part of the footprint closest to the point of intercept. (Aerospace Corporation, center for Orbital Reentry and Debris Studies, 2003)

Upon termination of the useful life of a space-based weapon, the weapon and its platform would be deorbited in a controlled fashion. The deorbiting process for a space-based interceptor would not be different from deorbiting activities for other DoD or commercial objects on orbit. During the controlled deorbiting process, the interceptor and its platform would either be placed in a disposal orbit, which is normally 300 kilometers (186 miles) above geosynchronous orbit, or lowered through the atmosphere where, after experiencing the friction and heat of reentry, remaining debris would be deposited in a designated area of the ocean. The majority of the platform would be expected to burn upon reentry. The on-board chemicals would also burn, destroying them; therefore, they would not pose a threat to human health or the environment. The impacts associated with debris from deorbiting the weapon and its platform would be similar to the impacts of debris from postlaunch activities described in Alternative 1.

Debris from a successful intercept or a launch mishap resulting in the activation of an FTS would reenter the Earth’s atmosphere in an uncontrolled manner. Missions are designed such that in the event of an FTS action by the flight safety officer, debris will reenter and impact either the BOA or on land on cleared ranges. It is also possible that during the planned deorbiting of a platform, the platform would experience a failure or lose communications with the ground controllers in which case the platform may reenter in an uncontrolled manner. In either scenario, the majority of the debris and platform would burn during reentry, resulting in a small amount, if any, inert debris reaching the Earth’s surface.

4.2.1.1 Air Quality

Impacts from Launch/Flight

The air emissions associated with launching an interceptor from a space-based platform would be the same as those emitted during launch from any platform discussed in Alternative 1. However, emissions produced in a space environment would not affect the human environment; therefore, there would be no impact to air quality from space-based interceptors.

Impacts from Debris

Upon reentry, the majority of the space-based interceptor and its platform would burn due to the intense friction and heat created during reentry through the Earth's atmosphere. Any on-board hazardous materials would burn and would not pose a threat to human health or the environment. Some small particles and pieces of debris may serve as reaction sites for chemical reactions in the atmosphere; however, due to the infrequency of debris reentry and deorbiting events, the impacts would be insignificant.

4.2.1.2 Airspace

Impacts from Launch/Flight

Although launch of the interceptor would occur in space, the interceptor may be directed towards the Earth during intercepts and could impact the use of airspace in the interceptor's designated path. Any potentially affected airspace would be cleared before launch of the interceptor. Coordination with the appropriate FAA ARTCC and relevant military installations with responsibility for airspace management would minimize the potential for any adverse impacts to airspace use and scheduling.

Impacts from Debris

For controlled reentries, it would be possible to indicate an area of airspace that would need to remain cleared during reentry events. For uncontrolled reentries, current capabilities and procedures provide a limited ability to predict within a 30-minute, 9,656-kilometer (6,000-mile) window when and where a particular object would reenter the Earth's upper atmosphere. (U.S. Strategic Command, 2002) Given the difficulty in predicting the path of uncontrolled reentering space-based interceptors and their associated platforms, little advance warning could be given to clear airspace. However, most objects break up and vaporize under aerodynamic forces and heating that occur during reentry. Thus potential impacts to airspace are not expected to be significant.

4.2.1.3 Biological Resources

Impacts from Launch/Flight

The launch of interceptors from space-based platforms could result in impacts to biological resources. In the event that an intercept was attempted and was unsuccessful, the trajectory used by the interceptor could cause it to hit the Earth's surface. The trajectory for test events would be carefully selected such that the interceptor would impact in a cleared portion of the ocean or in a cleared military range. Also, space-based interceptors may be equipped with an FTS. In the event of a launch mishap, the FTS

would be activated to destroy the interceptor, which would further reduce impacts to biological resources.

Impacts from Debris

Upon reentry into the atmosphere, the majority of the interceptor and platform would be expected to break up and burn up due to the frictional forces and intense heat created upon reentry. Therefore, any on-board hazardous materials would also be consumed and would not pose a threat to biological resources. The remaining debris would fall to the Earth's surface and likely fall into open ocean waters where impact would be limited to fish and marine animals in the immediate surface waters surrounding the impact point. Fish and marine mammals at lower depths of the ocean would have more time to react to the sound of the impact and would be able to avoid the impact area.

Debris could potentially be scattered over a wide area. Factors affecting an object's path could include variations in the gravitational field of the landmass and ocean areas, solar radiation pressure, and atmospheric drag. Objects reentering may skip off the Earth's atmosphere, similar to a stone skipping across a pond, causing them to impact much further away than originally predicted and unintentionally disturbing wildlife and vegetation. (U.S. Strategic Command, 2002) The impacts of debris affecting biological resources would be similar to the impacts of postlaunch activities as described in Alternative 1.

4.2.1.4 Geology and Soils

Impacts from Launch/Flight

No impacts to geology and soils would be expected from the launch/flight of space-based interceptors.

Impacts from Debris

Because interceptor and station keeping platform propellants would likely be consumed during reentry into the upper atmosphere, debris and deorbiting activities for space-based weapons and their platforms would not be expected to release toxic substances that would impact soils.

The impact of debris from space-based weapons platforms or interceptors reaching the Earth's surface and creating craters or impacting unstable soils would be extremely unlikely, as most debris would not survive reentry. Debris that might survive reentry would likely be very small in size and would not create serious impact force on the surface. Further, when possible, debris impact areas would be carefully selected to include deep ocean areas or designated locations on military ranges, where impacts could

be contained. Because of the infrequency of debris reentry and the expected small size of surviving reentry debris, no significant impacts to geology or soils would be expected.

4.2.1.5 Hazardous Materials and Hazardous Waste

Impacts from Launch/Flight

The launch/flight of interceptors would not produce hazardous waste that would be transported to or disposed on Earth.

Impacts from Debris

Debris that is contaminated with hazardous materials would reenter the Earth's atmosphere and be exposed to high temperatures during reentry. This would likely render the debris inert by the time it reaches the Earth's surface. Debris and deorbited material would not be considered hazardous waste. Therefore, there would be no impact on hazardous waste management from space-based interceptor debris.

4.2.1.6 Health and Safety

Impacts from Launch/Flight

Launch trajectories would be selected such that, in the event of an unsuccessful intercept attempt, the debris from the interceptor launched from a space-based platform would impact in the open ocean area or in a designated area on land. This would minimize the possibility that health and safety of people on the ground would be affected by launch/flight activities. Also, space-based interceptors may be equipped with an FTS. In the event of a launch mishap, the FTS would be activated to destroy the interceptor, which would further reduce impacts to health and safety.

Impacts from Debris

Launch trajectories would be selected such that the debris from a space-based platform would impact in the open ocean area or in a designated area on land. This would minimize the possibility that health and safety of people on the ground would be affected by launch/flight activities. However, in the event of uncontrolled deorbiting, there is potential for the subsequent debris (devoid of any potentially harmful chemicals) to hit and injure humans. However, as mentioned above, humans only inhabit one-eighth of the Earth's surface; therefore, any impacts to health and safety expected from debris and deorbiting material would be minimal. The risk that an individual would be hit and injured by reentering orbital debris is estimated to be less than one in one trillion. As a reference point, the risk that an individual in the U.S. will be struck by lightning is approximately one in 1.4 million. Over the last 40 years, more than 1,400 metric tons

(1,543 tons) of material is estimated to have survived reentry with no reported casualties. (Aerospace Corporation, Center for Orbital Reentry and Debris Studies, 2003) Therefore, the impacts to health and safety expected from debris and deorbiting material would be negligible.

4.2.1.7 Noise

Impacts from Launch/Flight

No impacts from noise would be expected from the launch/flight of space-based interceptors.

4.2.1.8 Transportation

Impacts from Launch/Flight

There would be no impacts to transportation from launch/flight of space-based interceptors.

Impacts from Debris

Any orbital debris falling into the open ocean would most likely not be recovered. Debris recovery on land would be as described for Alternative 1, and would not have an impact on transportation.

4.2.1.9 Water Resources

Impacts from Launch/Flight

There would be no impacts to water resources from launch/flight of space-based interceptors.

Impacts from Debris

Upon reentry through the upper atmosphere, space-based interceptors and components would be subject to extreme heat, destroying residual chemicals or rendering them inert. Therefore, no impacts to water resources would be expected from debris and deorbiting material.

4.2.2 Test Integration

This section assesses the potential for environmental impacts of BMDS System Integration Test activities under Alternative 2.

Description of Tests Analyzed

The System Integration Tests would incorporate land-, sea-, air-, and space-based platforms for weapons, sensors, C2BMC, and support assets. The System Integration Test activities under Alternative 2 would be the same as those presented under Alternative 1.

In addition to the land-, sea-, and air-based interceptors described under Alternative 1, interceptors may be launched from space-based platforms under Alternative 2. All other activities and their associated impacts from System Integration Tests would be the same as those described under Alternative 1. GTs would not involve weapons components; however additional sensor and C2BMC components would be required to control and coordinate the activities of the four weapon platforms (land-, sea-, air-, and space-based) under Alternative 2. The System Integration Tests conducted under SIFT Scenarios 1 and 2 could include launches of interceptors from space-based platforms. Other aspects of these tests would be the same as described under Alternative 1.

Environmental Consequences

Component testing would continue under Alternative 2. These tests would be conducted in addition to the System Integration Tests described under Alternative 1; System Integration Tests conducted under Alternative 2 also could include the use of space-based interceptors. Space-based interceptors would replace a land-, sea-, or air-based weapon launch or activation. Space-based interceptors would be capable of providing defense against threat missiles in all flight phases.

Impacts from activities that are discussed earlier in this PEIS, including System Integration Tests using weapons from land-, air-, and sea-based platforms will not be discussed in this section. The analysis of System Integration Tests under Alternative 2 will focus on those environmental impacts that are unique to the use of space-based interceptors compared to those described for System Integration Test activities under Alternative 1.

The unique activities associated with each type of System Integration Test analyzed in this PEIS under Alternative 2 include

- **Integrated GTs**. The use of additional components to control and coordinate the activities of the four weapon platforms (land-, sea-, air-, and space-based).

- **SIFT Scenario 1 – Single Weapon with Intercept**. The launch of interceptors from space-based platforms with an intercept.

- **SIFT Scenario 2 – Multiple Weapons with Multiple Intercepts**. The launch of multiple interceptors from multiple weapon platforms (land-, sea-, air-, and space-based) at up to two targets with intercepts. Under Alternative 2, the following analysis assumes that the launch of a space-based interceptor would replace a land-, sea-, or air-based weapon launch or activation. The use of support assets or C2BMC during test events is addressed under Alternative 1.

Tests Not Analyzed By Resource Area

- **Integrated GTs**. The use of additional components to control and coordinate the activities of a space-based interceptor would result in a negligible increase in the severity of the impacts across the resource areas presented under Alternative 1; therefore, impacts from GTs will not be considered further in this section.

- **SIFT Scenario 1 – Single Weapon with Intercept**. Under Alternative 2, the launch of the interceptor from a space-based weapon platform instead of a land-, sea-, or air-based platform as described under Alternative 1, would result in a negligible reduction (a beneficial change) in the overall impacts on each resource area. Under Alternative 2 an interceptor launch from a space-based weapon would replace the interceptor launch from a land- or sea-based weapon, which would result in a reduction in ground level emissions. Based on the projected target intercept flight path of a space-based interceptor, Alternative 2 may result in fewer impacts to airspace than Alternative 1. If the flight path were limited to the exoatmosphere, Alternative 2 would have fewer impacts to airspace than Alternative 1; however, if the flight path were directed towards Earth for an endoatmospheric intercept the impacts to airspace would be the same as for Alternative 1. The impacts of the launch of a space-based interceptor would be reduced for air quality, airspace, biological resources, geology and soils, hazardous materials and hazardous waste, health and safety, noise, transportation, and water resources. The impacts of the launch of a space-based interceptor are addressed in Section 4.2.2.10.

  The impacts due to debris from launching an interceptor from a space-based platform are not unique for either SIFT scenario. Launching an interceptor from a space-based platform could allow intercepts to occur at higher levels of the atmosphere than described under Alternative 1, but the impacts due to debris reentry would be the same as those discussed earlier in this PEIS.

Tests Analyzed by Resource Area

- **SIFT Scenario 2 – Multiple Weapons with Multiple Intercepts**. The following sections present the environmental impacts, by resource area, for SIFT Scenario 2. For this programmatic analysis, a qualitative impact assessment for each resource area

was completed because specific System Integration Test parameters have not been developed that would provide quantitative values.

4.2.2.1 Air Quality

Under Alternative 2, there would be fewer impacts on air quality than under Alternative 1. Should an interceptor launch from a space-based weapon replace an interceptor launch from a land- or sea-based weapon, a reduction in ground level emissions would occur. If the activation of an air-based weapon were replaced, then a reduction in emissions would occur in the upper atmosphere (12,192 meters [40,000 feet]). The intercept would occur in the upper levels of the atmosphere, and would potentially occur in the exoatmosphere, where the majority of debris would burn upon reentry into the Earth's atmosphere.

4.2.2.2 Airspace

Under Alternative 2, there would be fewer impacts on airspace than under Alternative 1. Launch of an interceptor from space could result in a reduction in potential interference with airspace. Based on the projected target intercept flight path of a space-based interceptor, Alternative 2 may result in fewer impacts to airspace than Alternative 1. If the flight path is limited to the exoatmosphere, Alternative 2 would have fewer impacts to airspace than Alternative 1; however, if the flight path is directed towards Earth for an endoatmospheric intercept the impacts to airspace would be the same as for Alternative 1. Whether the intercept of a space-based weapon occurs in the endoatmosphere or exoatmosphere, the debris associated with an intercept of a space-based weapon would have the same impact on airspace as presented under Alternative 1. For exoatmospheric intercepts, the majority of the debris would burn upon reentry into the Earth's atmosphere; however, airspace would have to be cleared to allow for any debris from such an intercept to pass through the atmosphere to the surface of the Earth.

4.2.2.3 Biological Resources

Under Alternative 2, there would be fewer impacts on biological resources than under Alternative 1. Launch noise produced from a space-based interceptor would not reach the Earth. Therefore, tests under SIFT Scenario 2 would result in a reduction in noise and pollutant emissions associated with a launch or laser activation which could adversely affect biological resources. Specific impacts on biological resources would be related to threatened and endangered species, unique or sensitive environments, and migratory, breeding, and feeding activities that occur in an environment affected by such activities.

Coordination and consultation with appropriate regulatory agencies, as well as adherence to appropriate and relevant regulations would be required to address any potentially significant impacts on biological resources. Site-specific environmental analysis would be completed to evaluate such impacts.

4.2.2.4 Geology and Soils

The activities performed under Alternative 2 would not impact geology. Under Alternative 2, there would be fewer impacts on soil than under Alternative 1. If an interceptor launch from a space-based weapon would replace an interceptor launch from a land-based weapon there would be a reduction in ground level emissions; however, if launch of a sea- or air-based interceptor were replaced, there would be no change in the impact on soils.

4.2.2.5 Hazardous Materials and Hazardous Waste

Under Alternative 2, there would be fewer hazardous material and waste impacts than under Alternative 1. Fewer hazardous materials and hazardous waste would need to be disposed on Earth under Alternative 2. Such reductions would occur through the reduction of a launch or activation of a weapon from the human environment and the associated use of hazardous materials, and generation of hazardous waste. Because no impacts were identified under Alternative 1 from the increased use and generation of hazardous materials and hazardous waste, no significant impacts would be associated with Alternative 2.

4.2.2.6 Health and Safety

Under Alternative 2, there would be fewer health and safety impacts than under Alternative 1. Launching an interceptor from space rather than from land, air, or sea would result in a reduction in the number of individuals that would be exposed to health and safety risks associated with launch activities. Because no significant impacts were identified under Alternative 1 from the increased use and generation of hazardous materials and hazardous waste, no significant impacts would be expected from Alternative 2.

4.2.2.7 Noise

Under Alternative 2, there would be fewer noise impacts than under Alternative 1. Noise produced from the launch of interceptors from space-based platforms would not be audible on Earth. Because no significant impacts were identified under Alternative 1 from increased noise, no significant impacts would be expected from Alternative 2.

4.2.2.8 Transportation

The transportation impacts under Alternative 2 would be the same as the impacts under Alternative 1.

4.2.2.9 Water Resources

Under Alternative 2, there would be fewer impacts on water quality than under Alternative 1. An interceptor launch from a space-based weapon would replace an interceptor launch from a land-, sea-, or air-based weapon, which would result in a potential reduction in the debris and simulants that would reach a water resource based on the altitude where an intercept or flight termination would occur. Specific impacts on water resources are related to the unique or sensitive environments (wetlands, marine sanctuaries, essential fish habitat) that occur in the biome, which would be affected by such activities. Coordination and consultation with appropriate regulatory agencies, as well as adherence to appropriate and relevant regulations would be required to address any potentially significant impacts on water resources. Site-specific environmental analysis would be completed to evaluate potentially significant impacts.

4.2.2.10 Orbital Debris

- **SIFT Scenario 1 – Single Weapon with Intercep**t. Increases in orbital debris would be greater under Alternative 2 than under Alternative 1. Under Alternative 2 a higher proportion of the SIFT Scenario 1 tests would occur in the upper atmosphere because of testing associated with the space-based weapon. As defined under Alternative 1, the orbital debris would not pose a significant impact.

- **SIFT Scenario 2 – Multiple Weapons with Multiple Intercepts**. Increases in orbital debris would be greater under SIFT Scenario 2 than SIFT Scenario 1. Under SIFT Scenario 2 space-based interceptors, may be launched at a target in the upper atmosphere. As defined under Alternative 1, the orbital debris would not pose a significant impact.

4.2.3 Cumulative Impacts

As described for cumulative impacts from Alternative 1, worldwide launch programs for commercial, civil, and military programs were determined to be actions of international scope that could be appropriately considered for cumulative impacts in this PEIS. The impacts of worldwide launch programs were considered in the discussion of cumulative impacts for Alternative 1.

Alternative 2 includes placing weapons on all platforms considered for Alternative 1 (land, air, and sea) and placing weapons in space. The air emissions associated with launching interceptors from a space-based platform would be the same as those emitted during launch from any platform discussed in Alternative 1. However, emissions produced in a space environment would not affect the human environment; therefore, the cumulative impacts analysis for Alternative 2 does not address the additive impacts of emissions produced by launches from a space-based platform. Placing weapons in space

involves adding additional structures to space for extended periods of time; therefore, it is appropriate to include in this cumulative impacts analysis other programs that are international in scope which place structures in space for extended periods of time. The International Space Station (ISS) was determined to be an action that is international in scope and has a purpose of placing structures in space for extended periods of time. Therefore the cumulative impacts analysis for Alternative 2 encompasses the discussion of worldwide launch programs as discussed for Alternative 1 and includes a discussion of the impacts of the proposed BMDS in conjunction with the ISS.

The ISS is a collaborative project including contributions from 27 countries worldwide. As originally designed, the ISS would have a mass of about 471,736 kilograms (1,040,000 pounds) and would measure 109 meters (356 feet) across and 88 meters (290 feet) long, with almost an acre of solar panels. (ISS, 1999) The first piece of the ISS was placed into orbit on November 20, 1998; the ISS is still under construction and therefore the current orbiting structure does not meet the dimensions described above. However, the ISS the largest single human-made structure currently orbiting in space.

The ISS maintains an orbit around the Earth. The ISS and other man-made orbiting objects can be adversely affected by orbital debris. Orbital debris is produced during orbital launches and would be produced during some proposed BMDS test events and activities including those used to place space-based weapons on orbit. If the orbital debris produced during BMDS activities was located in orbits on the same plane or higher than the ISS the potential would exist for orbital debris to impact the ISS. The extent of the impact of orbital debris on structures depends on the size of the debris and the velocity at which it is traveling.

Debris as small as a fleck of paint approximately 0.02 centimeter (0.008 inches) in diameter traveling at a velocity of three to six kilometers per second (two to four miles per second) has been documented to create a 0.5 centimeter (0.2 inch) indention in the windshield of the Space Shuttle. In LEO, an aluminum sphere 0.13 centimeter (0.05 inch) in diameter has damage potential similar to that of a .22-caliber long rifle bullet. An aluminum sphere one centimeter (0.4 inch) in diameter is comparable to a 181-kilogram (400-pound) safe traveling at 97 kilometers per hour (60 miles per hour). A fragment 10 centimeters (3.9 inches) long is roughly comparable to 25 sticks of dynamite. In general, debris smaller than 0.1 centimeter (0.04 inch) in size does not pose a hazard to spacecraft functionality. Debris from 0.1 centimeter (0.04 inch) to one centimeter (0.4 inch) in size may or may not penetrate a spacecraft, depending on material and whether shielding is used. However, penetration through a critical component, such as the flight computer or propellant tank, can result in loss of the spacecraft. Debris fragments between one and 10 centimeters (0.4 and 3.9 inches) in size will penetrate and damage most spacecraft. Astronauts or cosmonauts engaging in extra-vehicular activities could be vulnerable to the impact of small debris. On average, debris

1 millimeter (0. 04 inch) is capable of perforating current U.S. space suits. (Cour-Palais, 1991, as referenced in Commission on Engineering and Technical Systems, 1995)

In general, any orbital debris produced by BMDS activities would likely be small, primarily consisting of explosive bolts and small pieces of hardware. It may also be possible for debris related to an intercept to become orbital debris. However, because the majority of BMDS activities would occur in LEO where debris would gradually drop into successively lower orbits and eventually reenter the atmosphere, the debris would not be a significant hazard to the ISS. As BMDS testing becomes more realistic, there is potential for an increased amount of debris reaching and remaining on orbit. Most of this debris would likely not remain on orbit for more than one revolution, and eventually all of the debris would de-orbit. NASA and its ISS partners may be able to implement mitigation strategies to further reduce the impacts to the ISS from orbital debris. NASA and the U.S. Air Force Space Command monitor orbiting space objects and are aware of instances when the ISS is predicted to be in proximity to space debris that has the potential to damage spacecraft.

MDA would evaluate risk to existing space assets prior to test launches as indicated in Appendix L Orbital Debris. MDA would use launch window screening and schedule tests to eliminate risk of BMDS intercept debris impacting the ISS. Because the debris produced by BMDS activities would be expected to be small and would eventually be removed from orbit, and MDA would schedule launches to avoid the ISS, there would be no significant impacts expected to the ISS from the implementation of Alternative 2 for the BMDS PEIS.

4.3 No Action Alternative

Under the No Action Alternative, the MDA would not develop, test, deploy, or plan for decommissioning activities for an integrated BMDS. Instead, the MDA would continue existing test and development of individual missile defense systems as stand-alone capabilities. Under the No Action Alternative, individual components would continue to be tested to determine the adequacy of their stand-alone capabilities, but they would not be subjected to System Integration Tests. Further, C2BMC architecture would be designed to meet individual components needs and would not be designed or tested to meet the needs of an integrated system. The No Action Alternative would not allow for the effective development of an integrated BMDS to defend against threat missiles in all flight phases.

The No Action Alternative involves the continuation of current MDA activities for individual weapons, sensors, C2BMC, and support assets and would not include integration or System Integration Testing of these components. For the potential sites being considered for deployment, the No Action Alternative would be a continuation of activities currently occurring or planned at those locations. Therefore, the environmental

impacts associated with the No Action Alternative would be the same as the impacts resulting from existing activities assuming no integration. Because System Integration Testing would not occur under the No Action Alternative, the impacts associated with this testing would not occur.

The decision not to develop and field a fully integrated BMDS could result in the inability to respond to a ballistic missile attack on the U.S. or its deployed forces, allies, or friends in a timely and successful fashion. Further, the No Action Alternative would not meet the purpose of or need for the proposed action or the specific direction of the President and the U.S. Congress.

4.4 Adverse Environmental Effects That Cannot Be Avoided

Adverse environmental effects that cannot be avoided include the removal of vegetation during site preparation and construction activities; minor short-term noise impacts startling of wildlife; deposition of small amounts of pollutants on land, air, and sea; minor increased generation of hazardous materials; and emission of EMR.

In general, most known adverse effects resulting from implementation of the BMDS would be mitigated through project planning and design measures, consultation with appropriate agencies, and the use of Best Management Practices. As a result, most potential adverse effects would be avoided and those that could not be avoided should not result in a significant impact to the environment. Consultation with the appropriate agencies would result in the development of mitigation measures needed to ensure that impacts remain at less than significant levels.

4.5 Relationship between Short-Term Use of the Human Environment and the Maintenance and Enhancement of Long-Term Productivity

Section 1502.16 of the CEQ NEPA Implementing Regulations; require that the relationship between short-term uses of the human environment and the maintenance and enhancement of long-term productivity be discussed.

Proposed BMDS activities would take advantage of existing facilities and infrastructure to the extent practicable. The implementation of the BMDS would not necessarily preclude the use of facilities and infrastructure for other purposes. Therefore, options for future use would not be eliminated.

4.6 Irreversible or Irretrievable Commitment of Resources

Implementing the BMDS would not be expected to result in the loss of threatened or endangered species or cultural resources. However, some irretrievable resources would be used (e.g., construction materials, fuel, and labor). Site preparation and construction activities would result in some minor loss of biological habitat and wetlands, but impacts

would be minimized through the implementation of mitigation measures. Sensitive biological habitat would be avoided to the extent practicable. Proposed BMDS activities would not irreversibly curtail the range of potential uses of the environment. There would be no preclusion of development of underground mineral resources that were not already constrained.

Although the proposed BMDS activities would result in some irreversible or irretrievable commitment of resources such as various construction materials, minerals, and labor, this commitment of resources is not significantly different from that necessary for many other defense research and development programs carried out over the past several years. Proposed activities would not commit natural resources in significant quantities.

4.7 Federal Actions to Address Protection of Children from Environmental Health Risks and Safety Risks (EO 13045, as Amended by EO 13296 and EO 13229)

This PEIS has not identified any environmental health and safety risks that may disproportionately affect children, in compliance with EO 13045 as amended by EO 13229.

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